THE

PRINCIPLES OF AGRICULTURE,

BY

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TRANSLATED BY

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PRINCIPLES OF AGRICULTURE.

SECTION IV.

AGRICULTURE.

PART II.—ON THE TILLAGE OF THE SOIL, OR ITS MECHANICAL AMELIORATION.

I shall devote this portion of my work to an enumeration and description of those various labours and operations by means of which the soil is rendered capable of producing the various crops which we require from it, and by which its physical condition is adapted to the attainment of the end which the agriculturist has in view.

These operations are all comprised in the two following divisions:—

1. Those the effects of which are permanent, or at all events of considerable duration; such as are designated under the title of ameliorations, viz., the improving the land, the formations of hedges, ditches, and enclosures in general; also draining, digging, forming canals for the purpose of irrigation, &c.

2. Those which have relation only to the succeeding crops and to their sowings, and which must be repeated every year, or at any rate at certain short intervals. The latter are comprised under the denomination of tillage: various circumstances tend to induce us to occupy our-

selves in the first place with this division, and then proceed to a consideration of the more durable improvements.

However evident the necessity of tillage may be, there are, nevertheless, various opinions with respect to the manner in which it ought to be performed, as well in general as in special cases, and with regard to the selection of the various methods or practices which should be followed. Success has favoured alternately one or another of these; and hence an agriculturist who has received a merely practical education, will do well to act upon the precepts and follow the rules handed down to him by his forefathers. Such a course of proceeding certainly does not hold out the prospect of any advantages which are not likewise enjoyed by his neighbours, but at the same time it exempts him from the evils frequently entailed by speculations. Should he undertake new systems of operation without being thoroughly acquainted with their end and purpose, and with all the considerations which should induce him to follow or reject them, he will be far more likely to experience sensible losses than to attain to any real good. An enlightened and scientific agriculturist, on the other hand, whose endeavour it is to arrive at the highest degree of perfection of which his art is capable, may enter upon new modes of operation without risk, when he knows the effects which the course of proceeding he is adopting are calculated to produce, the results with which each operation will probably be attended, and can appreciate and understand the causes which have influenced the success of one mode, and sometimes of another.

The practice of agriculture has in view numerous and varied objects, all of which cannot be attained in the same manner. It is, therefore, highly essential that a clear idea should be entertained of the effect which is intended that a certain course of proceedings shall produce, not only in each isolated case, but also in the combination of all these cases with one another, in order that by means of this knowledge we may be enabled to select that mode of operation which will, at once, attain the required aim in the best possible manner and at the smallest possible expense.

The following are, in general, the objects and effects of tillage:—

1. *The loosening and pulverization of the soil.* All kinds of land have a natural disposition to agglomerate and become too close, either in consequence of the attraction of cohesion of their particles, or of the pressure exercised on them by the atmosphere. The more argillaceous a soil is, the greater is this consistence and agglomeration. But most of the plants we cultivate are unable to penetrate so hard a soil, or to derive from it the nourishment requisite for their support. It is, therefore, necessary that the soil should be loosened by some mechanical process; and this should be done as perfectly as possible, in order that rich vegetation may be produced, and all the nutritive matters contained in the ground be placed within the reach of the roots of plants. To effect this, it is requisite that the layer of vegetable earth should be pulverized, until not a single clod or lump remains. The fibrous roots of the plants do not penetrate these clods; all they can do is to wind themselves round them, and, consequently, clods of earth scarcely yield more nourishment than stones.

The more homogeneous, loose, and pulverulent a soil is, the more equally will it be penetrated by the roots of plants growing on it, the more hair-like and fibrous roots will these plants put forth, and the more are the ramifications of these roots separated from each other; so that thus all the nutritive particles contained in the soil are brought into contact with some one of the suckers put forth by the roots of the plants.

Some authors, and especially Jethro Tull, convinced by personal experience of the wonderful effects resulting from a complete pulverization of the vegetable layer of earth, have been led to believe that the fertility of the soil was produced solely by this cause; but it has since been clearly proved that such an assertion is not correct. When a field to all appearance exhausted has been allowed to agglomerate together in clods and lumps, there is no doubt that if it were carefully pulverized it might be made to bear one or two crops of grain: but this is only because the nutritive juices and particles which it contained are thus brought within the reach of the roots of plants, and not because this operation is able to create one particle of nutrition.

A soil can never be too much loosened and pulverized; it may, however, be rendered too light and spongy; that is to say, interstices may be formed in it, and there are vacuums existing between its particles. These voids or interstices are injurious to plants. It has often been noticed that divers kinds of products suffer when they have been sown on recently ploughed land which has not had time to sink down again, and, consequently, is full of interstices.

The comparative difficulty or facility with which this pulverization can be effected, depends in a great measure on the nature and composition of the soil: this is the reason that the operations, by means of which it is brought about, differ so much in their degrees of intensity, and why it is necessary to repeat them so much oftener on some soils than on others. Besides, the degree of pulverization bestowed on land must depend on the kind of plant which is to be sown there: barley thrives best on very loose and pulverized soils, while oats succeed equally well, if not better, on land which has not been so much loosened; this kind of grain vegetates most vigorously on those soils the particles of which agglomerate together.

Several years will elapse before a soil which has been properly pulverized will become hard, or before a crust will be formed beneath its surface. If it is composed of clay, it contracts a certain degree of adherence with itself; but this is never so great as to prevent the roots of plants from penetrating it, therefore the loosening and pulverization of that part of the soil beneath the layer turned up by the plough is seldom repeated above once in a certain term of years.

2. *The complete mixture of the parts of which the soil is composed.* It is never more imperatively necessary to

effect a thorough mixture of all the component parts of the soil, than when the layer of vegetable earth has been augmented by deep ploughings, which have brought the virgin earth to the surface, or by the addition of substances calculated to improve or ameliorate it. An earthy mass composed of heterogeneous substances is positively injurious to the roots of plants: vegetation is impeded when the young fibrous roots of plants pass from one kind of earth into another. An imperfectly mixed soil, consequently, produces stunted, sickly, and diseased plants: many soils have been rendered almost barren for several years, in consequence of the ameliorating earth which was carted on to them not having been properly blended with the vegetable mould; even the beneficial effects of marl are neutralized by want of attention to this essential point: in fact, the advantage which such substances are capable of producing never becomes apparent until they are thoroughly incorporated with the soil. Several kinds of manure, and especially those the fertilizing effects of which arise from their action on the humus and vegetable matters contained in the soil, likewise remain inert, if not properly divided and mixed with the vegetable mould, and are even likely to become injurious if they come in contact with the roots of plants before they are perfectly divided. Common stable manure is not altogether inefficacious, even when suffered to remain in lumps, because its soluble portions penetrate into the vegetable soil; but it is not productive of that amount of advantage which might have been derived from it, if it had been completely divided and mixed with the land by means of repeated ploughings. When stable manure has not been properly divided, the plants shoot up in tufts where they find an abundant supply of aliment; while those spots which contain little or no manure, either remain totally barren, or produce only a few sickly plants. A manure of this kind, when suffered to remain in the soil in lumps, subsequently forms a species of peat; and this inequality in the growth of the crops will continue for several years.

3. *The bringing a layer of earth, taken from a considerable depth, to the surface of the soil,* in order to submit it to the influence of light and of the atmosphere. From the remotest ages of antiquity, the advantages resulting from the aeration of land has been known and recognised by all attentive observers, and various hypotheses have been advanced to account for this fact. The effect thus produced has been compared to the formation of saltpetre (nitrate of potash), and, in fact, it is somewhat similar, since saltpetre is produced by the confluence of some atmospheric substances; and the oftener a new surface, and one which had not previously been saturated, is brought into contact with the air, the greater is the quantity produced. The same substance (oxygen) acts in this case as in the formation of saltpetre. It is by its assistance that those two matters are formed, in which carbon forms the constituent part of the nutrition of plants, namely, carbonic acid and soluble extract. It is only from exposure to the air that humus acquires its fertility, and there is little doubt that light has a good deal to do with the production of this effect.

The soil appropriates to itself that portion of carbonic acid which is formed by the combination of oxygen with the carbon, and that remains in the inferior stratum of the atmosphere, and is, in a manner, buried in the interstices of the earth which is turned over. It is not improbable that even the nitrogen contained in the atmospheric air, separated from the oxygen, has something to do with the amendment of the soil, and is absorbed by clay. Although we are not yet acquainted with all the various decompositions which are effected, yet general experience teaches us that even the most tenacious clays may be rendered fertile and permeable, by having their surface frequently changed, and fresh portions submitted to the action of the atmospheric air. The amelioration thus derived from the atmosphere, and the absorption of substances adapted for the fertilization of land, may be made to replace other ameliorations for a certain period of years; but the effects produced by it are neither so complete nor so durable. According to Du Hamel (Treatise on the Amelioration of Land, p. 64), the effects produced by this operation are so sensible that they are perceptible at first sight. "If," says he, "half of a field is moderately ploughed, and the other half repeatedly ploughed, and these two portions are subsequently ploughed athwart, that half which has been most frequently turned over and stirred will be much browner than the other.

4. *The absorbing, introducing into the soil, and preserving the moisture which falls from the atmosphere.* Moisture does not penetrate into argillaceous, close, or tenacious soils. When a clod of this nature remains unbroken in the soil, and becomes dry, it preserves the dryness in the centre during the whole summer. But the more the particles of the soil are separated from one another, and the more deeply the land is turned up, the more easily does the moisture penetrate into the interstices; in fact, the deeper the ploughing is, the more easily does the land absorb and retain humidity. When land has been thus prepared, the water does not flow back to the surface so soon, nor is it so speedily dried up and evaporated in dry weather, but communicated to the surface in proper proportions. These observations will be found to be every where confirmed by experience; and it has invariably been noticed that land which has been deeply and carefully turned over and stirred up does not soon become hardened on the surface, neither does it suffer so much as other land from drought. Every gardener who has dug up any portion of his land must acknowledge the truth of this observation. Soils which have been ploughed in the autumn resist the drought of spring in an almost incredible manner; in fact, they preserve a fair degree of humidity at the depth of an inch below their surface, while others are parched to a very great depth. It is not, therefore, literally true that ploughing dries land; such an effect can only be produced when the ploughings are deep and frequent, and always performed in dry weather. It has been observed

that a slight ploughing, which only moves the surface of the soil, tends rather to preserve than to dissipate the moisture; and, consequently, the insensible absorption of moisture by the soil from the air is greater than the evaporation.

The humidity which is enclosed in the interstices of the soil, and which amasses there in large quantities when the land is fallowed before winter, is doubtless attended with this disadvantage; but there is no reason to fear that it will render the soil too tenacious and compact during the whole summer. Attentive observers have remarked, on the other hand, that such soils are lighter, more friable, and divide with less difficulty, provided that we wait until they are dry: this is a natural consequence of the evaporation of that water the elasticity of which had separated the particles of the soil by introducing itself between them.

5. *The destruction of weeds.* In treating of the method of knowing and judging lands, we have divided weeds into two classes: those which increase and multiply by means of their seeds, and those which are propagated by means of their roots alone. This distinction is very essential as regards the destruction of weeds by ploughing.

Those weeds which are produced from seeds can only be destroyed by the seeds contained in the soil being successively brought to the surface, and thus enabled to germinate; for, otherwise, they might remain whole centuries in the land without losing their vitality. Many, and indeed by far the greater part of the little seeds do not germinate at all, unless brought into free contact with the atmosphere, which cannot happen while they remain enclosed in clods of earth; therefore, until these clods are pulverized, the seeds contained in them are totally inert.

There is not the least chance of completely destroying the seeds contained in the soil, or even in the part brought to the surface, unless all the clods and lumps of earth are thoroughly pulverized. It is not therefore sufficient that each layer, however thin it may be, should be brought to the surface, and into contact with the atmospheric air; it must also be broken, divided, and reduced to powder. The plough alone cannot effect this purpose, and recourse must likewise be had to the harrow.

But in order to clear the soil of those weeds which are propagated by means of their roots, and especially couch-grass *(triticum repens)*, creeping bent-grass *(agrostis stolonifera)*, and various other gramineous weeds; the corn or way-thistle *(serratula arvensis)*, and other varieties of thistle, docks, &c., a totally different course of proceeding must be adopted. The only means of destroying these plants is to break off the young roots and shoots, or to tear them up and expose them to the influence of light and air. They must be brought to the surface of the soil, separated from the earth, and placed in a position in which they cannot vegetate afresh, as they certainly would if the earth detached from the clods were suffered to fall on them again. The harrow while it tears up the roots from one place plants them in another, by surrounding and covering them with loose earth, in which they soon put forth new shoots. When, therefore, it becomes necessary to destroy such roots, the ground should not be harrowed until a short time before it is to receive a fresh ploughing; in order that the roots buried by the harrow shall not have time to vegetate before they are destroyed by the plough.

6. *Burying the manure.*—We have already spoken of the mode of effecting an admixture of the dung with the soil. When the manure is to be buried with the first ploughing, care must be taken that it shall be placed in a position where, according to its nature, it may produce the most immediate and beneficial effect on the first crop which succeeds the application; or, if the land has to be ploughed several times, that the manure shall be placed so as to be completely mixed with the soil. Long, strawy manure requires a deep furrow which will contain it; rotten dung, on the contrary, ought only to be covered by a very thin layer of earth; therefore the ploughings intended to bury it need not be very deep.

7. *Burying the seed.*—Whether this operation be per-

formed with the plough, the harrow, or any other instrument, the greatest possible attention must be bestowed on the execution of the ploughing which precedes the sowing, in order that the seed sown, whatever may be its kind, shall be placed in the position best calculated to facilitate its germination, when even the finest of its roots may be able to find nourishment and shelter, and where even its stem can attain the most perfect development without hinderance.

ON AGRICULTURAL IMPLEMENTS.*

Having pointed out the principal object which tillage is intended to effect, we will now proceed to examine

* The implements which mankind have employed in the cultivation of the earth, and their gradual improvement, (observes Mr. J. Allan Ransome, in his excellent work on the *Implements of Agriculture*,) is a theme closely connected with the history of agriculture.

In tracing the gradual progress of farming implements towards their present state of perfection, it will be readily understood how steadily, in all ages and countries, they have improved as agriculture has advanced, and how stationary they have ever remained in those countries where the science of agriculture is neglected. It would even seem that there is an intimate connection between the establishment of freedom of thought and of action, and of the progress of agricultural arts and agricultural life, of all modes of life the most conducive to health, to virtue, and to enjoyment. The cultivation of the soil necessarily requires the construction of implements for the purpose; and it is gratifying to observe the progress which has been made in them in Holland, in America, and in England, and contrast the beautiful and labour-lessening implements of agriculture which these free countries possess, with those of the cultivators of Spain, of Portugal, and of Russia, or of the more degraded slaves and ryotts of the countries of the East, such as those of Palestine, and of the banks of the Ganges. These, it is more than probable, have remained unaltered, without any successful attempt at improvement, for two thousand years. Thus we find that the Israelites, instead of employing in their warm climate a thrashing machine, or even a flail, to thrash out their corn, were accustomed to turn their oxen on to the barn floor to slowly tread out the seed. "Thou shalt not muzzle the ox when he treadeth out the corn." (Deut. xxxv. 4; 1 Cor. ix. 9; 1 Tim. v. 18.) And this rude mode is still the custom in Syria, and even in Portugal; and the Moors and Arabs (says Dr. Shaw, in his "Travels in Palestine,") still continue to tread out their corn in this way.

And, in accordance with this neglect of labour-lessening implements scarcely any expedients beyond the most primitive appear to have been adopted in the cultivation of the earth. Thus we find the prophet Isaiah declaring (xxxii. 20), "Blessed are they that sow beside still waters, that send forth thither the feet of the ox, and the ass." Sir John Chardin, and others, have described an indolent practice still prevalent in the Oriental countries, which explains this expression of the prophet. It seems that in planting rice, which is a crop that only flourishes in wet swampy grounds by the banks of rivers, that while the earth is yet covered with water they cause it to be trodden by oxen, asses, &c., and that, after the upper portion of the ground has been thus imperfectly disturbed, they sprinkle the rice on the surface of the water.

And if the ground is thus rudely prepared to receive the seed by the action into the nature and construction of the various instruments by means of which these different operations can best be accomplished, and the end in view attained with the greatest advantage and precision.

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of the feet of cattle, in a manner equally imperfect is the seed covered with the earth by these untutored cultivators. The English farmer must not expect to find in these ill-farmed and unenlightened countries any instruments even remotely resembling the compact and powerful harrows of this country; instead of these, the branch of a tree, or a few logs of wood fastened coarsely together, and dragged slowly over the surface of the very thinly and partially disturbed soil by oxen, are the only means employed to cover the seed. These instruments are thus described by G. W. Johnson: "When the plough has done its utmost on the stiff soils of Bengal, they still remain cloddy, and unfit to be a seed bed. To remedy this a still more imperfect implement than the Indian plough is employed, which is intended to produce the combined effects of the roller and the harrow. This is nothing more in form than an English ladder made of bamboo, about eighteen feet long, drawn by four bullocks and guided by two men, who, to increase its power, stand upon it as they direct, and urge on the cattle. Again and again has it to pass over the same surface, and then, as in the case of their plough, it causes a great expense of time and labour without any commensurate effect. The Indian ryotts show their consciousness of the reason that the operation of pulverizing and levelling is beneficial, by calling it *Rasbandham*, that is, *the confining of the moisture*."—*Asiatic Res.*, vol. x. p. 4.

And, in countries somewhat more civilized, the construction of agricultural implements has hardly progressed more rapidly than in the East, for even in many parts of Europe they still use ploughs of the heaviest and most ill-constructed character. Their teams, too, are equally neglected; horses, cows, asses, and even goats, are harnessed together in a most wretched manner, just as was the custom, it would appear, in very primitive times in Palestine. (Deut. xxii. 10.) The German farmers still use, instead of a plough, an instrument called a "haken," which is exactly similar to one used by the Roman farmers. Their harrows have commonly only wooden teeth, and are worked with five horses in a very bungling manner. (*Johnson's Farm. Encyclopædia*, p. 559.) And still farther north, the Muscovite harrows are formed even in a ruder way, by merely fastening together the branches of the fir tree, whose projecting, partially trimmed spurs form the teeth, while the implement they use for a plough is little more than a shapeless bundle of sticks tied together with tarred rope.

As long, in fact, as men continued to till the earth as slaves, sowing a crop they were not sure of reaping, degraded in spirit, and totally uneducated, it was in vain to expect superior implements of any kind, or any efforts, however slight, towards the improvement of agriculture. In our own island, for instance, ploughs were, during the early and dark ages of its history, rudely constructed, intolerably heavy, and of all kinds of shapes, a result which might have been reasonably anticipated; for by an old British law every ploughman was required to make his own plough. The harrows and other agricultural implements were equally ill-shaped. Drills were utterly unknown until about the sixteenth century. And when, about the year 1730, the celebrated Jethro Tull endeavoured to banish the flail from the barn, his neighbours loaded him with execrations. The tradition of the neighbourhood of Prosperous farm, near Hungerford, which Tull cultivated, still is, that he was "wicked enough to construct a machine, which, by working a set of sticks, beat out the corn without manual labour." This is the earliest traditionary notice of a thrashing machine with which I am acquainted. Jethro

These instruments are divided into two classes, those which can be worked by manual labour, and those which cannot be used without the intervention of draught cattle. The former are only adapted for the cultivation of gardens, and, therefore, scarcely come within the province of this work. There are however, no doubt, circumstances under which these instruments may be used with advantage in the tillage of fields, but such cases are of rare occurrence. Whether or not, it may be advantageous to substitute the spade or hoe for the plough when a sufficiency of labourers can be obtained, is a problem which we are not called upon to solve, since in by far the greater part of Europe spade-husbandry cannot be employed to any great extent without employing more hands than can be spared from other occupations; and in those places where the population is sufficiently numerous to admit of this being done, the tillage of fields is replaced by the cultivation of gardens. We may, therefore, regard digging and ploughing as the distinctive characteristics of these two kinds of cultivation.

There is not a doubt that land may be as well tilled and rendered as fertile by means of good agricultural implements worked by cattle, as it could be by manual or spade-labour, and at much less expense. The crops which succeed to a good digging are, however, often far better than those which follow a slight or careless ploughing.*

Tull, indeed, must ever be regarded as one of the earliest improvers of English agricultural implements; his ploughs, his horse-hoes, and his ingenious attempts to construct a drill machine evince a spirit of inquiry, and an advance in agricultural mechanics, which betoken at once his ability and his enthusiasm. He was far indeed before the general agricultural knowledge of his age; and if he did now and then suffer his enthusiasm to carry him too far in his conclusions, yet the very effort to improve in hands like his was sure to be attended with a measure of good success, for his exertions not only produced immediate good fruits, but they widely diffused a very general and well-founded suspicion that the implements of that age were not quite so perfect as they might be made. This led to considerable improvements, and prepared the way for still more important efforts by the next generation of implement makers.

* Spade husbandry has certainly been extending itself in England within the last few years. The late Dr. Yelloly described its introduction into the parish of Wymondham, in Norfolk, where it seems many acres were dug (land after a

The instruments that are used for the purpose of tilling the soil and preparing it for the reception of the seeds

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white crop) at 2d. and 2½d. per rod. Of late, the fork has in many places superseded the spade, since it lessens labour, and is better adapted to penetrate the hard substances on which many shallow soils rest. The spade has long been employed in the husbandry of Spain, France, and other continental states. The Rev. W. Rham observes, (*Journ. Roy. Ag. Soc.*, vol. ii. p. 43,) "The husbandry of the whole of the north-eastern part of East Flanders, where the soil is a good sandy loam, may be considered as a mixed cultivation, partly by the plough and partly by the spade. Without the spade, it would be impossible to give that finish to the land, after it is sown, which makes it appear so like a garden, and which is the chief cause of the more certain vegetation of the seed. There is a great saving of seed by this practice, as may be seen by comparing the quantity usually sown in Flanders with that which is required in other countries, where the spade is more sparingly used. In large farms in England, the spade is only used to dig out water-furrows, and to turn heaps of earth, which are made into composts with different kinds of manure. But in Flanders, where the land is usually laid in stitches of about six or seven feet wide, the intervals are always dug out with the spade, and the earth spread evenly (*sifted*, as they call it) over the seed which has been harrowed in.

The trenches are so arranged, that every year a fresh portion of the ground is dug out, and in six years the whole land will have been dug to the depth of at least one foot. In the next course, the trench is dug a few inches deeper, which brings up a little of the subsoil; and, after four or five such courses of trenching, the whole soil comes to be of an uniform quality to the depth of eighteen or twenty inches; a most important circumstance to the growth of flax, potatoes, and carrots, all of which are very profitable crops to the farmer, and the two last indispensable to the maintenance of the labourers and the cattle. In the Waes country, they proceed differently, for they have a soil which, by repeated trenchings, has long been uniform in quality to the required depth. There they regularly trench one sixth part of the land every year, and plant it with potatoes, or sow carrots in it.

In a recent communication Mr. J. Beadel, a very experienced farmer and land-agent of Witham, in Essex (who has used a fork of an improved construction to a considerable extent), observes, when comparing the use of the fork with that of the spade:—

1. A man can dig a greater quantity of land in a given time with the fork, than he can with a spade—my experience proves one-sixth; and it strikes me it must be so, because the chisel-pointed ends of a three-pronged fork, can be more easily pushed into a hard subsoil, than the continuous end of a spade.

2. It does not bring up so much of the subsoil as the spade, but mixes the earth more, a great portion slipping through between the prongs.

3. The bottom is left more uneven and broken by the fork than by the spade, which I consider an advantage. One great objection to the plough is, I think, the smooth glazed surface which it leaves below, and which in many cases, I fancy, presents too great a resistance to the delicate fibres of the plant. This is *heterodox*, but if true, the plough will be altered *one day*. And if Mr. John Morton be correct, that in most instances the present surface soil is nothing more than a portion of the subsoil improved by cultivation, it must be right to increase the quantum of corn-growing earth by subjecting more subsoil to the same operation. In digging, I sometimes use the fork in the furrow, and then plough on to the dug land, and so keep the top soil on the surface, without bringing the hungry subsoil into play, till after it has been subjected to the operations of a regular rotation.

and plants, and which are worked by cattle, are very numerous, but they may all be comprised under the three following classes :—

(a) The *plough.*—The intention of this implement is not only to divide the earth, to loosen and throw it a little on one side, but also to turn it over from a given depth, so that the lower part of the furrow separated by the plough shall be brought to the top, and a new surface exposed to the atmosphere. This effect is produced by that part of the instrument which is termed the mould-board, and which is usually placed at the righthand side of the plough.

(b) The *grubber.*—This instrument loosens, stirs, and divides the soil, and cleanses it from roots and weeds, but does not turn it over; because it has not a mould-board.

(c) Hoes and *cultivators.*—Under this denomination I comprise all kinds of horse-rakes, hoes, extirpators, scarifiers, drills, and sowing machines, &c., which only loosen the surface of the soil, and which are used for the purpose of preparing and effecting the sowings, or cultivating the crops during their vegetation.

*The plough,** in the strictest sense of the word.—This implement ought to separate or detach from the

* I must beg my readers to regard the minute directions given, rather as intended to assist in the choice and use of ploughs, than in the fabrication of them. It is exceedingly necessary that an agriculturist should not only perfectly understand the effects which will be produced by certain modifications in the form of the plough, but likewise to be able to remedy those inconveniences which are frequently met with while using this implement; in fact, he ought to know how to employ it so as to produce the greatest advantage. The author, doubtless, has this end in view in the instructions which he gives. But agriculturists are very much mistaken when they imagine that they can invent new ploughs, and have them constructed on their own premises, and under their own eyes. These kinds of instruments are not easily imitated: their mechanism is difficult, and requires skill and attention: those persons, therefore, who choose to invent and fabricate them themselves, instead of procuring them from the proper manufactories, lose a great deal of time, and expend three or four times the sum which it would have cost them to procure the plough even from a considerable distance. The usual effect of such attempts is to disgust the essayists with all improvements, and to cause those who relate actual facts to be accused of forming speculative and groundless opinions.

I have, myself, experienced the annoyances from which I am endeavouring to preserve others. I endeavoured, for a long time, to construct one of Small's ground successive sods or slices of earth parallel with the surface, but cutting them vertically by means of the coulter, and horizontally detaching them by means of the share, raising them in general from the left and turning them quite over by means of the mould-board, so that they shall be brought as much as possible within the reach of the harrow, which should then be used to break or powder them completely. A well-formed plough is that which will perform these operations with the least resistance, in the most perfect manner, with the least

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ploughs, according to the directions which I found in several English authors, and flattered myself that I had attained some degree of success, but it proved to be ephemeral. Attributing those imperfections which resulted from my own inexperience, to the nature of the thing itself, I uttered a general protest against all ploughs having an immoveable and concave mould-board, until reflection convinced me of the utility of a principle which, in spite of my failure and mistakes, appeared to be evidently good. At this period, Schwertz's work on the agriculture of Belgium was obligingly forwarded to me by the celebrated de Fellenberg; I there found a description of the Ostmale plough, which threw a new light on the subject. But, this time, I determined not to risk the success of my experiment by entrusting the fabrication of this instrument to the workmen in my vicinity; I therefore ordered it direct from Ostmale, and obtained very satisfactory results from the first trials which I made of it. But I continued to experience innumerable difficulties when I endeavoured to get this instrument imitated by the workmen in my neighbourhood, and, at length, was once more obliged to send for a plough from Ostmale, which, notwithstanding the expenses of carriage, was actually cheaper than those made in the neighbourhood, besides being very superior in quality. From that time the Ostmale plough has risen, every day, in my estimation, and in that of several persons in the vicinity; and even my labourers, now they have learned how to guide and make use of it, prefer it to all others. I hope that I shall not be considered as trespassing on the patience of my readers, if I say a few words relative to the disadvantages attending experiments with regard to the action of this instrument, which are made without proper precaution and preparation, and in which the plough has been hastily constructed by unskilful hands. After the success which I obtained from the use of the Ostmale plough, I wrote to Fellenburg on the subject. Some time afterwards, when the period fixed for the fête at Hofwyl was approaching, this celebrated agriculturist wrote me that he had made known this plough to the public, and, consequently, that he hoped I would procure him one against the fête. I surmounted many difficulties in order to fulfil his wishes, and the work was hurried on, perhaps with too much precipitation. The plough was just finished in time to reach Hofwyl on the day of the meeting of agriculturists there; it appeared a facsimile, but there was no opportunity of trying it before hand, and, when put in action in the presence of those assembled, the results obtained were any thing but satisfactory, on account of some inaccuracy in the smith's work, arising from want of skill. Hence, the numerous agriculturists who were assembled at Hofwyl were led to believe that the Belgium plough did not possess all the good qualities attributed to it, and this opinion was rapidly diffused through Switzerland. Even up to the present day, the unfounded prejudice thus excited continues to exist, notwithstanding the invariable success which has attended the action of this instrument when used in its original form, and not spoiled by bungling workmen.—French Trans.

risk from strain or shock, and which tries the strength of the cattle as little as possible; neither should the guidance of it require any great degree of skill, or give the ploughman too much trouble.

The other qualities which constitute a good plough are as follows:—

1. It should be as simple in its construction as the end which it is destined to attain will admit; and consequently should have no useless or too complicated portions.

2. It should not be very expensive. If, indeed, a plough which costs three times as much as another will last four times as long, it will of course be cheaper.

3. It should be durable and not liable to injury, shock, or strain; not only in order that it may not cost too much, but also because it should not require repairing too often, and thus occasion an interruption of the operations and the loss of considerable time.

4. It should be capable of being easily guided and regulated, in order that the soil may be ploughed more or less deeply at will, and the furrows turned up of that size and form which is deemed best. This disposition of things should be wholly independent of the ploughman, both because it is not always possible to confide in him, and because the cattle have to work harder when the labourer is striving against the natural tendency of the plough.

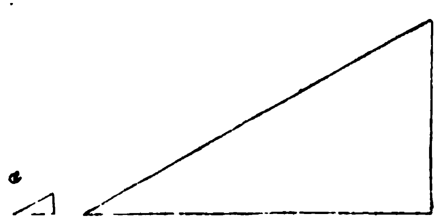
It is likewise necessary that it should effect all those purposes pointed out in the last section, that it should cut through the earth which it has to separate, and turn it over in an equal and uniform manner; and that it should turn over the furrow slice at an angle of 140 degrees, that being an inclination which is most favourable to the action of the harrow, and consequently facilitates the pulverization of the soil.

Although the plough is one of the most necessary of all the implements employed by husbandmen, there is, perhaps, no one to which so little attention has been paid, or which has been less improved; and those alterations which have been made in its construction are, in general, far from being improvements, since most of the ploughs of the present day are, in point of fact, inferior to those used by the ancients; and even those in use among some of the less civilized nations are preferable. Our carriages are far superior, in point of style and convenience, to the triumphal cars of the emperors, at least if we may judge from the representations handed down to us; but our ploughs are not as perfect as those used by the ancient Romans. Some persons have hence inferred that the form of their plough was not susceptible of improvement, and argue that if this instrument had been capable of being constructed on any fixed principle, it must have been discovered during the long use which has been made of it. But, if we come to consider the kind of persons who have, until very lately, had to do with ploughs, and how seldom these instruments have been in the hands of men endowed with any great degree of reflection, science, observation, or mechanical knowledge, we shall cease to wonder at the little progress towards improvement that has been made; the fact is, that the plough has kept pace with the intellect of the men who have had to do with it.

Since this point has been taken into consideration and the attention of scientific men directed to it, it has no longer been denied that the amount of labour requisite to work a plough, and the rapidity or slowness with which the operation of ploughing can be performed, depends in a great measure on the structure of the instrument; and it is also allowed that this structure contributes materially towards the success of the crops and the increase of the products. Although some modern authors appear to discredit these facts, or at any rate not to believe that the expenses attendant on the introduction of new ploughs can be sufficiently compensated by the benefits resulting from their use; and, although some agriculturists assure us that they can obtain very fine crops without having recourse to any change, this only tends to prove that they cannot form an idea of the saving of time and labour resulting from the use of a good plough. The general improvement of agriculture certainly does not depend solely on the beneficial alterations which can be made in the structure of the plough and other agricultural instruments; nevertheless, this science will never attain to all the perfection of which it is susceptible until proper attention is paid to this important point. It is on this account that a judicious and scientific agriculturist cannot do without an intimate acquaintance with, and a clear idea of, the functions and mechanism of this implement.

The essential and active parts of a plough, those which are generally called the body, are composed of the following pieces :—

(*a*). The *coulter*. The use of this part is to cut the sod from the firm ground previous to its being raised and turned over, and to open a passage for that part of the plough which is in a direct line with it; it ought to keep the plough even, and prevent it from turning towards the right. The coulter ought to be inclined in an oblique direction, in order to give the plough a leaning in the same direction to which it points. If we picture to ourselves the body of a plough as resembling a half angle, or a rectangular triangle, the coulter will in a manner form the point of the angle; it will prolong the side which falls perpendicularly on the base of the triangle, as in the following diagram, where *a* designates the point of the coulter.



This point determines the direction of the plough, and the manner in which it moves; and in proportion as this side of the instrument is longer, the direction will be straighter, and the action firmer.

As the extremity of the blade of the coulter forms the extreme point of the triangle or oblique surface, in order to render the plough perfect, this portion of it should never be suffered to deviate from that obliquity: we find all good ploughs constructed in this manner. The blade of the coulter is sharp at the edge, but gradually thickens towards the back, which is sometimes nearly or quite an inch thick. This increase of strength does not exist on the side which meets the undivided land, but on the opposite one; and, consequently, the segment of the coulter ought likewise to be in the form of a rectangular triangle. By this means the left side of the coulter will be in a direct line with the left side of the body of the plough.

In order that the coulter may open a path for the body of the plough, it is placed a little in advance of it; the point of this instrument is usually about as far before that of the share as is equal to its width. The inferior part of the sod or furrow slice separated by it from the land, is then more easily cut by the wing of the share, raised by the share itself, and thrown to the right of the plough by the mould-board. Thus, the plough is better engaged in the soil, and its course is more even.

If the coulter is not thus constructed and cannot be placed in this position, attempts are made to attain the same end by introducing the hilt into the beam in an oblique direction, so that the sharp side shall be turned outwards, and a little to the left; while its back, on the contrary, shall be on the right side, and face the land already ploughed. But it is evident that this arrangement must tend to increase the friction and render it greater than it would be if the coulter were in the position above described. It is equally necessary that the hole destined to receive the hilt of the coulter should be larger than the hilt itself, in order to leave room for the introduction of those wedges which must be inserted to give to the blade the proper direction. It is by no means an easy matter to place this blade properly, or to arrange the wedges as they should be; this operation requires a great deal of care and skill, gives much trouble, and recurs very frequently, and by such means the work is frequently interrupted.

It is usually necessary to slant the wedges in order to give the blade of the coulter a sufficient inclination to the left; for the hole destined for the reception of the hilt being in the middle of the beam, a coulter placed in it in a direct line would incline too much to the right, and would not be before the point of the share, especially as the body of the plough, as we shall presently see, is not exactly in a line with the beam, but deviates a little to the left. By means of wedges, the proper direction may be given to the coulter; but then it is not perpendicular, the superior portion of the hilt inclines to the right, while the sharp point is turned towards the left. It does not, therefore, cut through the soil perpendicularly, but in a sloping direction; and does not open so free a passage for the body of the plough as it ought to do. In a superficial ploughing of only three or four inches in depth, the increase of friction which will result certainly is not of any great importance; but it becomes more sensible when the land has to be ploughed to the depth of six inches; on this account, therefore, those ploughs which are intended to turn up the soil to any considerable depth, have the coulter bent below the hilt, as is the case in Small's improved plough. By means of this bend, the coulter, properly so called, (its blade,) receives an inclination as much to the left as is requisite, although the hilt is placed in a perpendicular position. For deep ploughing, in which the plough has to overcome great resistance, the firmness and solidity of the coulter may be greatly increased by means of a piece affixed to it with a screw, as is the case in Small's improved ploughs. By curving the coulter in the manner above stated, one great inconvenience is avoided; the man who guides the plough is not obliged to keep it constantly inclined towards the side on which the soil is untouched in order to keep it sufficiently engaged in the land. This arrangement enables the ploughman to cause the coulter, however slantingly it may be placed, to cut perpendicularly; but a still greater evil than the one just mentioned is thus produced, namely this—the share ceases to be in an horizontal position, and the furrows cut by it, instead of being even, are much thicker on the side next to the unploughed land, than they are on the opposite side, and, consequently, the ploughing is very irregular.

Coulters are constructed under various forms; sometimes they are perfectly straight, at others curved like a sickle, and at others inclined in the opposite direction, having a bulge in the centre. These various forms are supposed to facilitate the entrance of this instrument into the soil: but as a curved line is longer than a straight one, it appears to me that they rather tend to increase the resistance, and that a straight coulter is by far the most preferable. The facility which a curved form is intended to give to the action of the coulter, is attained quite as well when this instrument is inclined and its point projected forwards; for it is well known that a coulter always cuts best when it acts in a sloping direction, although in a line with the motion given to it. Where such is the case, the coulter cuts outwards, and is thus more easily enabled to break through the adherence of the integral portions of the soil; it then raises up the sod or furrow-slice, facilitates the entrance of the share which follows it, and tears up those roots which are too large for it to cut through: its inclined blade tends to force them upwards, so that they must either break or be torn from the soil; whereas, a coulter placed perpendicularly would push those roots which it could not cut through, onwards to the firm ground, where they would impede the motion of the plough. This instrument also raises those stones which it would be impossible to throw on one side, or push forward. Lastly, an oblique direction of the coulter has the advantage of giving the plough a slight tendency to enter more deeply into the soil without increasing the friction too much. The pressure of the soil on the coulter, by steadying the anterior portion of the plough in the earth, compensates for the power exercised by the draught, which rather tends to raise this instrument. The coulter of a plough used on land which has not been freed from stones, should deviate more from the perpendicular than would be requisite in any other case; in fact, it may receive an inclination of thirty degrees from the direct line of the perpendicular.

As the coulter not unfrequently has to encounter considerable obstacles and resistance, its strength should be proportionate to the force which it has to overcome; and as the whole of this strength cannot be given in thickness, the breadth must also be augmented. Three inches will in general be sufficient; but where the soil gives considerable opposition to the action of the plough, this breadth may be increased.

The coulter ought to be laid with steel, and as it undergoes a very great degree of friction, the steeling must often be renewed. If the same coulter is almost always used, this steel will seldom last more than a year; and in stony soils not more than six months. As the position of the coulter has considerable influence on the direction of the plough, particular attention should be paid to this point, especially if the coulter is not a very good one, and can only be kept in the proper position by means of wedges. The overseer, or inspector of farm works, will, therefore, do well to examine all the ploughs every day, and especially this part of them, and see that everything is in its proper place; the best way to effect this surveillance thoroughly will be to have the ploughs turned over; the time thus spent could not be better employed.

There are districts in which this important part of the plough is altogether done away with, and where it is replaced by that part of the share which terminates it on the left side, and which is on the same plane with the left side of the body of the plough. But it is only where the land is light, free from stones, and homogeneous, or where superficial ploughings alone are requisite, that it is possible to do without the coulter. On soils of an opposite nature, which require to be deeply ploughed, a plough without a coulter will perform its work very imperfectly, and will increase the labour of the draught cattle as well as that of the ploughman.

The second essential part of a plough is the *share*, which separates the furrow-slice horizontally. In all well constructed ploughs, the share ought to begin to raise the sod, and to conduct it towards the mould-board on an oblique but uninterrupted surface. The share is composed of two parts—that which cuts, and which is generally called the *wing*, and that by means of which it is affixed to the body of the plough; the latter is termed the *socket*. The form of the first is greatly varied; in general, however, it is shaped like a rectangular triangle. On the side next to the unturned earth, it is in a line with the coulter and the body of the plough, and is not sharp: it is highly necessary that this direction of the left side should be carefully attended to, or otherwise the plough will not move steadily. The other side of the wing, that which is sloping, is usually laid with steel, and sharpened; it extends from the left side of the plough, and forms an angle of about forty degrees. Occasionally it receives a yet sharper angle of about thirty-five degrees, in order that it may penetrate more easily into argillaceous and tenacious soils; but it is evident that in this case the coulter must be proportionally lengthened if we would have the bases of this rectangular triangle remain the same. Sometimes this triangle is composed of one single piece of iron, and is perfectly hollow; at others, it is hollow in the middle, and surrounded by three sides. The first of these two methods is evidently preferable, because the furrow-slice separated by the blade of the share may then be gradually raised with much less friction, and passed to the oblique surface which conducts it to the mould-board.

The hinder part of the wing ought to be proportionate to the furrow-slice which it is intended to separate from the soil; that is to say, the breadth of the wing at the base ought to be nearly equal to the width of the furrow; or, in other words, the angle at the right of the share, and which forms the posterior extremity of its blade, ought to be as distant from the left side of the body of the plough as the lower part of the mould-board which rests against the slice turned over. I say nearly, because when the breadth of the furrow is nine inches, the wing may measure one less; the mould-board then turns the slice better on its own axis, because a small portion of it still remains uncut, and in contact with the soil. But this difference must not exceed an inch; if it does, the friction is increased, and the plough moves with less ease on account of the mould-board then having to overcome much greater resistance in raising the slice.

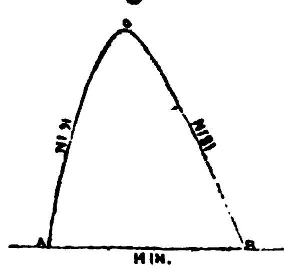
According to an essay on dynamics, the moving power requisite to put in motion a plough, the share of which was five inches wide, diminished fifty pounds, when a share measuring seven inches in width was substituted for the one just mentioned. Nevertheless, many ploughs are manufactured, the shares of which are too narrow even when first made, and this is an evil which is daily increased by use and wear.

The second part of the share is the *socket*, by means of which it is attached to the plough: this portion is made and fixed in various ways. The practice of fastening on the share with nails is a very bad one, and can only be used where the land is light and soft, and where it is rarely necessary to sharpen or steel the share. It is sometimes affixed to the plough by means of cramp-irons or hinges: those of our ploughs which are best made are merely united by means of grooves; but then, in order that the share may be sufficiently firm, the wood and iron must be very carefully worked.

A well-formed share ought, as I have already stated, not only to separate the slice from the soil, but also to raise it, and to form with the mould-board an even surface, which, beginning at the point of the share, gradually rises obliquely at the side. The wing of the share is itself convex, and rises as it approaches the left side. The socket must not interrupt this elevation, but rather continue it, by serving to unite the share with the mould-board, so that no inequality shall break the uniformity which ought to exist from the point of the share to the posterior part of the mould-board. This is the great and distinguishing merit of Baily's and Small's ploughs, and contributes materially to decrease the amount of friction. In common ploughs there is generally an inequality at this point, which causes the slice to be depressed before it is again raised by the mould-board.

I have met with farmers who were fully sensible of the inconvenience of this construction, and who had endeavoured to obviate it by affixing a piece of iron to the neck and to the ear, which was made to rest on the hinder part of the share. They assured me that their ploughs were considerably improved by this means.

With respect to the form of our shares, I must refer my readers to the description of them which I have already given in my work entitled "Beschreibung der nutz barsten neuen Ackergeruethe," heft i., tafl iv., fig. 1, 2, and 3. As the socket of the share ought to be very carefully united to the body of the plough, and especially to the mould-board, many smiths find it an exceedingly difficult matter to execute this work; but this difficulty would be got rid of if they procured a model or mould of iron, around which the share may be cast in a uniform manner. They can then cast the iron of the shares, giving to them the following form and thickness:—



At A the plate is ½ an inch thick
„ B „ ⅜ „
„ C „ ¼ „

When this plate has been curved on the model, it fits the body of the plough very well, and carries the furrow slice on to the mould-board with the least possible degree of friction.

This socket is applied to the neck or sheath of the plough, which is lengthened about a foot for the purpose of receiving it; it is, of course, understood that the form of this part must be made perfectly similar to that of the share. See my work above mentioned, heft i., tafl v., fig. 15 and 16.

The neck or forepart of the plough serves to unite together the different pieces at their lower extremity; it slides along at the bottom of the furrow, supporting itself against the unturned earth. In front the neck or sheath is introduced into a mortice, and at the back the left handle is united to it in a similar manner. The socket ought to have two sides, both perfectly connected together, the under one and the lefthand one which unite in forming a right angle.

In general, and in all good ploughs, the socket is protected with bands of iron as well on the lower portion as on that which rubs against the unturned earth; by this means the friction is considerably diminished, and the wood preserved from being worn away so soon as it must inevitably have been without this precaution. The same may be observed with regard to ploughs, the whole sockets of which are formed of forged or cast iron; these are principally intended for the purpose of breaking up meadow land; many of them are in use in the low country and in the marshes in the neighbourhood of the Oder.

The length of the share determines that of the body of the plough. The question has been much disputed, whether or not, the breadth being equal, that share, the triangle of which is long, will not be superior to that in which the triangle is short, and consequently to that in which the angle is less acute. Those who argue in support of the former opinion, allege in defence of it, that the more acute the angle, the more easily does it enter the ground; or, to speak scientifically, the less sensible the obliquity of a surface is, the greater will be the facility with which a body can be raised on it. But here, as in most cases, that which is gained in power is lost in speed; and thus the results are rendered equal. The longer the body of a plough is, the greater will be the friction and consequently the more laborious will its progress be; therefore it would be expedient to make the bodies of ploughs very short, if it were not that their progressive motion would be rendered less straight and regular, and if when longer they had not more firmness both on the left side, which rests against the unturned earth, and on the lower part. Small's ploughs have short bodies, while Baily's have long ones; the latter, therefore, proceed more evenly and steadily, and can be confided to unskilful hands with greater safety.

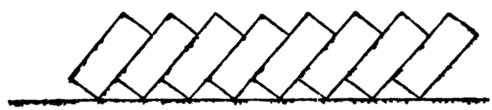
The *mould-board* is that part of the plough which characterizes it, and serves to distinguish it from all other agricultural implements. This part ought to raise the slice which has been separated by the coulter and share, to turn it over and throw it into the furrow which was previously made. Here, then, is the greatest degree of resistance, and the ease with which it may be overcome depends upon the construction of this part of the plough. The mould-board is usually made of a thin board nailed to the right side of the head of the plough, near to the share, and the hinder part of which is maintained in its proper place, and fixed to the handle and head of the plough by means of one or two rests. The oblique and advanced surface of this board enables it to throw the furrow-slice to the right of it, but it does not turn it completely over; for unless this slice is tolerably firm and consistent, it will still adhere partially to the soil. In order that this may be properly accomplished, the length of the mould-board at its hinder extremity ought to be half the size of the slice raised by the plough. It is also requisite either that the mould-board should form a more obtuse angle with the left side of the plough, or that it should be very long. In either of these cases the weight of the earth and the friction will render the progress of the plough difficult, because the whole weight of the earth rests upon the mould-board until it has passed its extremity. The quantity of earth which rests against the mould-board, and the friction produced by it, are the very causes which retard the progress of the plough.

But if the mould-board were so constructed as to enable it to free itself from this load of earth sooner, the plough would be considerably lightened. This constitutes the great advantage which curved mould-boards have over others, especially when, as I have before mentioned, they unite with the share in forming an even and uninterrupted surface. By means of this curvature the slice, in passing over the share and on to the mould-board, is turned on its own axis; so that when the revolution is half performed, it hardly touches the plough, but is impelled towards the opposite side by its own weight, and only requires a very slight touch of the posterior point of the ear to turn it over as thoroughly as is necessary.

There are still various conflicting opinions with respect to the form which it is desirable should be given to a mould-board, as well as with regard to that which is best calculated to turn over the slice in the easiest and most complete manner. In the "Museum of Natural History," No. 4, p. 322, there is a very circumstantial mathematical calculation given by president Jefferson, of the United States, which almost exactly answers to the mould-board of Small's ploughs. Baily has written a paper in some other work, in which he endeavours to prove that his plough is the best; but the opinions of husbandmen are still divided between the respective merits of the two. The latter raises the slice almost insensibly, and causing it to perform two-fifths of a circle, turns it over on its axis; Baily's plough produces a similar effect, but in a less perfect manner. Small's instruments are best adapted for ploughings which extend to more than eight inches in depth; while those of Baily do the work quite as well when merely superficial ploughings are requisite; and as the latter do not need so much care and attention, and it is easier to remedy error or accidents in them than in Small's ploughs, they are perhaps, on the whole, preferable, especially as they are more easily guided. The differences, however, which exist in the various forms can only be explained by reference to the ploughs themselves. The mould-board of Small's plough is deeper; it raises the earth higher before throwing it on one side, and it also turns it over more quickly. From being higher and shorter it sustains less friction; the difference, however, with respect to this point is only observable in deep ploughings. These two ploughs are equally capable of gradually and obliquely raising the slice, and of conducting it on an even surface from the point of the share to the mould-board which turns it and throws it on one side. The mould-boards of both of them get rid of the earth a great deal sooner than flat ones do. For common use, Baily's plough may be regarded as the best that can possibly be had; although the ploughings performed with Small's plough are far more perfectly and beautifully executed when this instrument is well made.

Curved mould-boards are also frequently made of wood; but when this is the case, the blocks must be chosen of sufficient thickness to allow their receiving the proper form, and they must likewise be covered with plates of iron, otherwise they will soon wear away and become uneven and rough. Cast-iron mould-boards are much cheaper, and, provided that the iron is not too brittle, are also more durable; besides, iron has another great advantage over wood, it causes less friction, and when polished retains less earth on its surface.

Most of those mould-boards which are not curved turn the slice over in a very imperfect manner; only a portion of the earth raised by the share is thrown above that which previously formed the surface, unless indeed the earth consist of a continuous strip of turf adhering to itself. In order to produce a proper reversion of the soil, the distance which separates the body of the plough from the hinder part of the mould-board must be much greater; the mould-board must push the earth much further than would otherwise be necessary, and the plough must trace a wide furrow even when the slice is narrow. The furrow in this case is sometimes half as large again as the slice. In order to throw this slice to such a distance, a greater degree of power will be requisite; because the earth rests much longer on the mould-board. Those ploughs, on the other hand, which have a curved mould-board, do not, properly speaking, throw the slice on one side, they merely turn it on its right shoulder. Many persons believe that flat, uncurved mould-boards turn the slice over better, because the surface of a soil which has been ploughed with an instrument having one of these is always more even and horizontal. It is most true that the slice can be turned over much better when the furrow which is to receive it is considerably wider than the slice itself. Our ploughs turn the soil over, so that one slice rests upon another in the manner here represented.



The above form is exactly the inclination at which the spaces which are left open between each of the slices are most likely to effect the amelioration of the soil in the best and most perfect manner; by this means the air is, in a manner, enclosed in the soil and brought into contact with the inferior and under portion of it. These voids also serve to retain the water deposited by rain, &c.; and when this moisture is evaporated by heat, it tends greatly to improve the land, and the soil gradually settles down and fills up all the interstices. This surface contains as many prisms as there are lines or streaks, and has many more points of contact with the atmosphere than a horizontal surface could possibly have; the harrow also acts more efficiently on it than on an even surface, not only pulverizing the soil completely, but also tearing up all the roots which it contains. Therefore, in all soils which require to be divided and loosened, this inclination of the slices is attended with manifest advantage; and it is only on light soils that it can by any possibility prove prejudicial. Agriculturists, whose land is of a light and friable nature, need not trouble themselves about the form of their ploughs; they may continue to employ those generally used in their vicinity, however imperfect they may be. Nor would our ploughs be productive of any bad effects, because light sandy soils not possessing any consistence will soon sink down and fill up those interstices which would otherwise remain empty.

Lastly, there are convex mould-boards made of wood or iron; these are chiefly met with in the neighbourhood of the Rhine. Ploughs of this kind turn up the soil quickly, and progress without difficulty; but they do not turn the slice over well unless their mould-boards are made very long, which would tend greatly to increase the friction.

The piece by means of which the lower part of the plough is united to the *beam*, and which forms the anterior portion of the body of the plough, is termed the "neck" or "throat;" it is usually made of wood; and it is only in Small's ploughs that it is formed of iron. In all improved ploughs this piece is not perpendicular at the lower part of the instrument, but is inclined, so that the highest part of it at the back forms an angle of from 80 to 85 degrees. By means of this inclination that part of it which immediately follows the coulter is better able to overcome the resistance which it encounters, and is not so soon worn by friction. When the mould-board does not preserve it from wearing, recourse is had to another means of rendering it sharp; a strip of iron is then affixed to it, or that piece of iron which terminates the plough on the left hand side is lengthened;* this is the case in Small's ploughs. Some ploughs are to be met with in which the coulter rests immediately on the throat, and forms the extremity of it,† but they are de-

* Beschneibung der Ackergeräthe. Heft. i. Tafl 2, fig. ii.
† Ibid. Heft. i. Tafl 6, fig. ii. A.

prived of the advantage resulting from this prolongation of the left side, which cannot take place without increasing the friction. However undeniably advantageous this inclination of the throat may be, many ploughs are constructed in which it is made to turn in quite an opposite direction. A very slight examination will, however, enable us to perceive that such an arrangement is much less advantageous, and that it renders this portion of the plough much less durable.

The *beam* is that portion by means of which the progressive motion that causes it to move through the earth is communicated to the body of the plough, and which regulates the line of draught which it is impossible to attach to the body itself.

The beam is usually affixed to the forepart of the body of the plough by means of the neck or throat, and to the hind part by means of the left handle. The union of these parts ought to be effected, so that when the draught power is attached to the proper place, the plough shall move horizontally through the earth at the same depth to which it was first introduced.

If the beam is raised too high in front, or if the neck is too long, the share is apt to penetrate too deeply into the soil; it is then said that the plough moves on its point; on the other hand, if the beam is too low and the neck too short, the share has then too great a tendency to rise out of the soil. The plough ought to move horizontally forward, or at any rate, parallel with the surface of the land, and at the same depth at which it was first placed, so that the lower part of the share and the under side of the heel of the plough shall be at equal distances from the surface. This horizontal motion is communicated to wheel ploughs by means of a lever, or by elongating or shortening the beam. In those which are without wheels, or in other words, in swing ploughs, the same effect is produced by elevating or depressing the line of draught which is affixed to the bridle at the end of the beam; but the elevation of the beam then acts inversely on the share, to which it communicates a tendency to penetrate deeper into the earth. When this is the case, the share no longer proceeds horizontally, it tears rather than cuts the soil, and the labour of the draught cattle is rendered exceedingly fatiguing. It is on this account that in wheel ploughs the throat is not firmly morticed into the beam, but merely affixed to it by means of a wedge, and that some little play is allowed in the mortice, which serves to unite the beam with the handles, in order that the beam may be raised or lowered at pleasure by means of a wedge. But where this is the case, the labourers are too apt to alter the position of the wedges in order to be more certain that the share will not rise out of the ground. Notwithstanding this, the plough cannot penetrate to any very great depth, being prevented by the beam, which is itself restrained by the axis of the fore-wheels on which it rests. The beam in this case exercises a very great degree of pressure on the axis, and thereby increases still further the obstacles which the draught cattle have to overcome. This may be carried to such an extent as, on tenacious soils, to cause the beam to snap at that place to which the bridle is affixed. In wheel ploughs this defective position of the beam is not so sensibly felt, and does not matter so much, but in swing ploughs the labourer can with difficulty contend against the inconveniences occasioned by it.

The length of the beam varies both in wheel and in swing ploughs. The longer it is, that is to say, the more distant the point of *traction* is from the body of the plough, the more steady will the motion of this instrument be, because then the slightest deviation of the share will be sensibly felt at the extremity of the beam: but this increase of length tends materially to diminish the strength of the beam; and, consequently, it must be made thicker in proportion as it is elongated.

Small's ploughs have shorter beams than Baily's, and that is one reason that they are more apt to deviate from the straight line. The beams of most wheel ploughs are usually made longer than is necessary, so much so that they project far beyond the axis. The point of the beam which rests on this axis may be drawn nearer to the body of the plough, or placed at a greater distance from it as circumstances seem to render necessary; in the former case, the point of the share will be raised, and in the latter, depressed. In order to effect these modifications, several holes are made in the beam, to any one of which the ring at the end of the chain may be affixed by means of notches or of a pin, called a cheek, and the plough let down to a greater depth below the axis, or taken up.

Viewed in its horizontal direction, the beam has not the same tendency as the body of the plough, but rather inclines a little to the right. If the beam were placed in an exact line with the left side of the body of the plough, the share would not incline sufficiently towards the left, and would have a tendency to rise out of the soil. In constructing a plough, however, if sufficient care has not been taken to avoid this inconvenience, some means must be sought to remedy it; this is effected in wheel ploughs by placing the beam on the left side of the axis, and in others, by attaching the line of draught to the last hole on the right side of the bridle or regulator. But this effect will always prevent the possibility of cutting wide furrow-slices, even when such a proceeding appears to be advisable. As the beam is always a little smaller towards the foremost end, the wood is raised a little on the left side, while the opposite one is left perfectly straight.

The *handles* are those pieces of wood by the means of which the labourer introduces the plough into the soil, and corrects its deviations. Properly speaking, these are not used for the purpose of directing the plough, since, if it is well made, it will of its own accord pursue the path traced out for it. But when this instrument encounters some extraordinary obstacle, and one or more of its parts receive a shock which causes it to deviate from a direct line, it is then the office of the ploughman to restore it to its proper position; but this must not be done by needless violence, but by a temperate and gentle exertion of strength. He ought to be so well accustomed to his duty as to be able to feel at once, by the sensation communicated to his hand, any deviation of the plough, however slight, and to be ready to remedy it, as it were almost instinctively, by an opposite movement.

Ploughs are made with either one or two handles, but, in point of fact, only one is necessary, namely, the left. Most agriculturists prefer wheel ploughs with only one handle, in order that a ploughman who is accustomed to the use of them may have his right hand at liberty to use the whip, or that little instrument by means of which he removes roots or rubbish and earth which may be collected on the mould-board, or in front of the plough. Two handles, they affirm, render the ploughman idle, and encourage him to lean on the plough, by which the labour of the draught cattle is considerably augmented. Nevertheless, it cannot be denied that the right handle is occasionally useful, that it assists materially in fixing the plough in the soil, and in overcoming those obstacles which it encounters more quickly; and that, moreover, when this handle is held with a firm grasp, and with the right arm slightly bent, it acts in opposition to the earth, which, resting heavily on the mould-board, might easily cause the plough to incline towards the left, and render the slices uneven.

In common wheel ploughs the handles are placed at the hinder extremity of the plough, in order that by their means a sufficient degree of perpendicular pressure may be exercised upon it when it is desirable that the instrument shall penetrate more deeply into the soil; but should the soil be hard, the only effect produced by this pressure will be the raising of the point of the share. In English ploughs without wheels, the handles or stilts are brought more forward towards the front of the instrument, and placed at the point where it experiences the greatest resistance: on their re-ascension at the back of the plough they are extended to a sufficient and suitable length. By means of these levers the labourer, without any great degree of exertion of strength, is enabled to resist all the deviations of the plough.

But the slightest pressure on these handles is here so sensibly felt, that the chief difficulty attending the use of these ploughs, is to make the ploughman abstain from all violence, and from all sudden jerks of the hand. In general, men who have never ploughed before, are easily taught the use of swing ploughs, and how to guide and manage them; whereas, those who have been accustomed to this operation all their lives, almost invariably commit the great error of leaning too heavily on the handles. As soon as a person is accustomed to manage the handles, to raise the hinder part of the plough a little when it seems disposed to quit the ground, and to press upon it when it penetrates too deeply, the direction of these swing ploughs becomes so easy that a child of twelve years old might manage them. It is only when the land is unequal or hilly, or when the plough meets with some unexpected obstacle, that the ploughman is obliged to have recourse to the handles, in order to keep the plough in the direction which it ought to go. Many persons have imagined that it is difficult to turn ploughs without wheels, when they have reached the end of the piece which is to be ploughed, and when it becomes necessary to commence a fresh furrow; but they are quite wrong, for there is no other plough with which this can be so easily effected. All that is requisite to be done, is for the labourer to incline the instrument on the right side, suffer the draught cattle to pull it round, right it by means of the handles, raise these latter a little, in order to enable the share to penetrate the soil, and then allow the plough to proceed on its course.

It always ought to be possible to regulate a plough so as to cause it to make the furrows of the width and depth which we wish them to be. The arrangement by means of which this is effected, is attached to the extremity of the beam, and is very different in wheel ploughs from those which are without wheels.

In the former, when the part of the beam which extends from the point where it rests on the axis, to the body of the plough, is elongated, the plough has a greater tendency to penetrate into the earth; whereas, if it were shortened, the contrary effect would be produced. Those holes which are observable in the middle of the beam, are intended to effect this elongation or a diminution of length. But where the desired effect cannot thus be produced as perfectly as is necessary, a regulator is generally placed in front of the throat, or wedges are inserted at the hinder end of the beam, by the means of which this latter may be raised or lowered. The regulators are constructed in various ways. In wheel ploughs, on the mechanism of which greater care is usually bestowed, their effect may be graduated in an almost insensible manner. They are often so contrived that by these means the breadth of the furrow-slice may be increased or diminished: for example, if the beam is inclined more to the right, the share will be turned more to the left, and will cut a wider slice. In order, however, to cut the furrow-slices of any considerable width, the point at which the draught power is attached to the fore-wheels must be altered; and this is effected by means of a regulator. By means of the teeth of this last-mentioned piece, the traces and the wheel carriage may be shifted to the right or the left at pleasure. The contrivances attached to ploughs to effect this purpose are numerous and various; but there is no occasion to give a special description of each. The most simple, certainly are the best; and this will be found in the description of the Norfolk plough, by Dickson. This is the most perfect wheel plough of any with which I am acquainted. The regulator is made of iron, and, consequently, is rather more expensive. Nevertheless, if we come to consider on the one side how much more durable iron is, and with what rapidity the bar may be suspended in the notches; and on the other hand, how apt inventions of a similar kind are to break when constructed of lighter materials, and the difficulty in making them sufficiently firm, we shall come to consider it as very economical. The Norfolk plough is, however, only calculated for very light ploughings which do not exceed three inches in depth.

In order to regulate the depth to which a plough shall penetrate the earth, it is only necessary to raise or lower the line of draught attached to the bridle at the extremity of the beam, or to advance this point or draw it back. If we wish to determine before hand, according to a given height taken from the point of draught of the animals, and according to a certain length of traces, to what depth the plough will penetrate the soil, a straight line must be drawn from the former to the body of the plough, passing by that point at which the traces are attached to the beam. The plough enters the earth at the place where this line falls. The lower the point to which the traces are attached, the nearer will the extremity of this line approach the point of the share; and the higher it is, the further will it rise on the body of the plough. But in using swing ploughs, it is quite sufficient to know that by lowering the point to which the traces are attached, the ploughings will be rendered more superficial; and that by raising it, the depth to which the plough penetrates the soil will be increased. The most superficial examination will convince any person who has a swing plough before his eyes, that this raising or lowering can be effected with the utmost facility and promptitude.

By means of this regulator a tendency may also be communicated to the plough, which leads it to incline more to the left or the right; or, in other words, to cut larger or smaller slices. To effect the first, the bar is attached more to the right; and to effect the second, more to the left.

Although the use of wheel ploughs is so widely diffused, that in some parts of Germany the farmers have no idea of ploughs without wheels, these latter are very useless appendages, excepting in a very few isolated cases. They increase the weight which the draught cattle pull, without producing any advantage, and seem to owe their invention to erroneous views, and the introduction to their ingenious appearance.

Wheels never can contribute to lighten the load; for when a plough is properly regulated, the extremity of the beam scarcely touches the axis. It is only when some defective tendency of the instrument drags it into the soil, that the beam rests heavily on the axis, and then the resistance opposed by the plough is rendered greater from the line of draught being interrupted and receiving three distinct tendencies: one from the point of draught to the under part of the fore wheels; the second, from this point rising towards that point of the beam to which the bridle is attached; and the third, from this latter point to the share.

It is a very general opinion that the addition of wheels renders the motion of the plough firmer and straighter, and that by their assistance the instrument is better able to resist those obstacles which might turn it aside from the direction which it ought to follow, and that they render the task of guiding it less difficult. But they can only produce these effects by allowing the beam being made longer, so that the length of the lever may give it sufficient strength to resist the deviations of the share; and in this case, when the resistance is of a nature which admits of its being easily overcome by a plough, it will be possible to surmount it quite as easily with a swing as with a wheel plough; and as the shortness of the beams of swing ploughs is the chief cause of their being so liable to be thrown on one side, when they are well made they are so constructed as to give the labourer sufficient command over them to prevent this deviation, an advantage which cannot be given on wheel ploughs. Even when this resistance is not of a nature to admit of its being easily overcome by the instrument, swing ploughs are preferable, because they run much less risk of being broken by the efforts of the cattle, in consequence of their springing, as it were, aside; and besides, a ploughman who is accustomed to guide them, will feel at once, by the sensation communicated to his hands, whether or not it is possible to overcome the obstacle which presents itself; and can, therefore, by means of a slight pressure, assist the instrument, and if necessary turn it aside, so as to prevent it from sustaining any injury.

I used to be of opinion that a large wheel plough was best adapted for the purpose of tilling stony, uneven ground, full of roots, or of clearing an uncultivated soil; but experience has convinced me of my error. I have broken up land filled with roots of trees, by means of Small's plough, and Baily's, and with a draught power far less than that which would have been requisite to work a large wheel plough. I have tilled land of this nature with only two horses, on which it would have been impossible to make use of a large wheel plough, without attaching at least six horses to it. I must, however, confess, that the chief cause of the advantage of these swing ploughs arose in part, if not wholly, from the coulter having been firmly fixed, in the manner recommended by Small.

If ploughs without wheels lose a little of their steadiness from the motion which they experience at the extremity of the beam, this inconvenience is more than compensated by the power and command which the labourer has over them. By means of the slightest pressure he can cause the plough to incline towards the left, and thus cut a wider slice; or, by turning it towards the right, he can dispose it to quit the soil. By raising the handles a little, he can cause it to penetrate deeper into the ground; and by lowering them, prevent it from entering any further, or cause it to rise out of the soil altogether. Where the surface of the soil is level, he has no occasion to use any of these precautions: all he has to do is to suffer the instrument to follow its natural course. The great superiority of swing ploughs over wheels is particularly striking on uneven, hilly ground, which is full of risings and declivities. On such land wheel ploughs act unequally, and trace furrows of various depths. This may easily be accounted for. When they ascend a rising ground, the fore-wheels are higher than the body of the plough, and, consequently, the point of the share is lifted up: in this case it only cuts a very thin slice, and sometimes rises out of the earth altogether. On the other hand, when the plough is going down hill, the fore-wheels are lower than the body of the plough, and then the share penetrates too deep. These inconveniences can only be remedied by regulating the plough in a different way every time the inclination of the soil varies; all endeavours made by the labourer to remedy it in any other way will be perfectly useless. This is never more evident than when a field, divided into ridges, is ploughed across with a wheel plough: as the fore-wheels ascend the rising surface, the share hardly touches the ground; on the other hand, when they descend into the furrow, it enters too deeply. Now, with a swing plough, the ploughman can, by means of the long handles with which it is furnished, overcome these obstacles, and trace an even furrow without much difficulty or the exertion of any great degree of strength.

All ploughmen are well aware of the great difficulty there is in making a wheel plough penetrate a hard tenacious soil. Not one of the numerous contrivances used under similar circumstances, nor of the alterations which are made in the plough every time it is put in the ground, nor the pressure on the instrument effected by the conductor which ascends to the beam, nor the bringing the head nearer to the hinder part of the perch, not one of these remedies are at all efficacious, and the operation is either badly executed or cannot be performed at all. A plough without wheels, having a share which is, perhaps, a little more pointed, ought, when the handles are slightly raised, to penetrate even a barn floor, if such a thing were necessary, and if the moving power attached to it is sufficient to cut the hardest soil; indeed, provided that the requisite number of draught cattle are employed, no degree of draught or hardness of the soil can impede its action.

The greater the simplicity of the mechanism of ploughs without wheels, and the increased solidity of their parts, cannot be overlooked; they are less liable to be damaged or injured, and thus that time is saved which is too often necessary to be devoted to the repairing of such implements.

In wheel ploughs, the wheels are not always well made; there can be no doubt that large well-rounded wheels are far superior to those which are small and ill-constructed: this advantage is not, however, very great, and does not contribute so much to diminish the resistance as some persons think.

Sometimes the wheels move round on immoveable axletree: at others they are affixed to the axle, or to an iron axletree, which itself revolves in the body of the wheel carriage. The latter are generally preferred, especially when the wheels are low, either because the axle will not then be so soon worn out by the friction of the soil, or because, in the other case, it is impossible to prevent some portion of earth from insinuating itself between the smallest wheel and the axle on which it turns; this plan is not, however, without its inconveniences.

Sometimes the wheels are of equal dimensions: at others, the spokes of the right wheel, or that which moves in the furrow, are increased to the depth of the furrow, or nearly so. When the wheels are of equal diameter, the fore part of the plough is necessarily placed in an oblique position. This obliquity increases the friction so much, and inclines the fore part of the beam so much towards the right, that this plan is only practicable for superficial ploughings of not more than three inches in depth. Whenever it becomes necessary to plough the soil to a greater depth, the diameter of the right wheel must be proportionably increased in order to bring the wheel-carriage into an horizontal position. But if two wheels of unequal size are affixed to the same axle, at each revolution the smaller one will remain behind, and has to be dragged after the other, for two wheels of unequal dimensions moving on the same axis have not an equal progressive motion. The right wheel, which is largest, keeps in advance of the other, and tends to throw it on the left side; it consequently rubs against the unturned soil, and is thus repelled, so that the wheel carriage of the plough vacillates and the friction is considerably augmented. If the wheels are different in diameter, it is highly requisite that at least one of them should move round the axle.

An inequality of the wheels is likewise attended with considerable inconvenience when we come to plough with raised furrows. If the furrow already raised must be still higher, at the first motion of the plough, the right wheel which stands highest is immediately placed in a more elevated position, and the fore part of the wheel-carriage so much inclined that it frequently turns over, and it is impossible to fix the share in the soil; it likewise often happens, when the soil inclines on the side of the furrow, that the right wheel is obliged to move in the preceding ridge. It is also found that the first and last furrows of large raised ridges are always badly executed, unless every care is taken to arrange the plough so that it shall be capable of performing them properly, which is a matter of great importance in this mode of tilling land.

These are some of the inconveniences attending the use of ploughs with fore-wheels, which are at best very useless appendages, and serve only to increase the resistance and the friction.

The only case in which I can give the preference to wheel ploughs is, when they are used not for the purpose of breaking up rough, uneven, and tenacious soils, which oppose considerable resistance to the action of the instrument, but only when they are employed for the purpose of performing shallow ploughings with large ridges on a flat surface. Here the fore wheels will prevent the instrument from penetrating too deeply into the soil, and cause it merely to pare the land. A wheel plough may be more easily arranged so as to make it cut larger slices than a swing plough; indeed, this can only be effected with the latter by a peculiar construction.

Sometimes a foot, similar to that on which the beam rests, is affixed to the plough instead of wheels; and the lower part of this is terminated by a kind of hoof, or by a little wheel which occupies the place of the coulter. At other times, two wheels are affixed to the back of the plough.

The plough most generally used in Belgium is of the former description; and Schwertz, in his account of the agriculture of Belgium, maintains that it is far superior to all other ploughs. The body of this instrument certainly is excellent in form; but the foot on which its foremost part rests, and which drags through the soil, necessarily intends to increase the friction. It can hardly be said to contribute to steady the motion of the plough, and it is likely to prevent the ploughman from having as much control over the instrument as he otherwise would. The only advantage which can be derived from it, consists in its tendency to diminish the effect of any erroneous motion made by the ploughman. This addition appears to have been made solely because the inventor feared that it would be impossible to teach labourers the proper method of guiding these ploughs. This foot cannot be used on uneven ground; for as soon as it touches an elevation, or a stone, the point of the share rises out of the ground, or, at any rate, to the surface of the soil.

It is always better to substitute in place of this foot a small wheel, similar to that on the skimming plough. This wheel occasions less friction. A similar wheel has also been adjusted to the front of the body of the plough, in the place of the coulter, and the outside of it sharpened. It is thought that by this means the separation of the slice, especially if it is turf, is facilitated; but it cannot be denied that it is very difficult to cause this wheel to penetrate the ground. In fact, it can only be effected by giving the share too great a tendency to enter deeply into the soil, or by means of fore-wheels, which depress the beam. Both these methods augment the friction and the resistance, without procuring any advantage which would not have been attained equally as well by means of the coulter.

Endeavours have also been made to add a small wheel to the hind part of the plough, in order to diminish the friction of the heel at the bottom of the furrow. The inconvenience of this addition is manifest.

A wheel with iron spokes, and without joints, has also, occasionally, been affixed to ploughs. This is placed at the side of the mould-board, across which its axle passes, and is supported at the opposite end on the bottom of the left handle. The outer extremity of the spokes are made in the form of a shovel; and it is pretended that by this contrivance, the earth of which the slice is composed is turned over, and thoroughly loosened and divided. In light, sandy soils, this wheel divides the sand very well, and produces the intended effect. But the friction is so much increased, that it becomes necessary to support the plough on the opposite side to prevent it from turning over. On argillaceous and tenacious soils, where this invention might possibly be useful, it is incapable of producing any effect.

Among the numerous improvements and additions which have been made to the plough, I shall only notice the following.

As the reversion of the slice cannot always be effected in a sufficiently complete manner, a moveable plate is added to the hinder part of the mould-board at that part where it rises above the earth, or a triangular piece which can be projected forwards by means of a screw is joined to this part by means of hinges or of thin, flexible plates of tempered steel; the screw passes from the inside through the lower part of the handle of the plough opposite the back of this moveable piece, and can keep it in any required degree of inclination, which will enable it to overcome all the resistance of the double ploughs, of which we shall presently have to speak.

There is no doubt that it may be productive of much benefit, but this is not obtained without a considerable increase of friction, and without requiring, on the part of the labourer, a constant counter-pressure to prevent the plough from being turned over. It has been asked if the reversion of the slices could not be much more completely effected by a man walking behind the plough than by having recourse to any of these improvements which are very apt to get out of order. A somewhat similar effect is obtained from the *elongated Belgian mould-board*, which is composed of a board that serves to lengthen the mould-board, and of a piece of hard wood which forms the handle of it. This elongation is affixed to the body of the plough by means of a hook which fastens into a ring placed behind the mould-board. A young lad holds the handle and stands in such a position as to cause the elongation to form with the mould-board a more or less obtuse angle. He advances in a line parallel with the plough, and raises or lowers the handle according as the resistance of the slice appears to require it. This addition ought to be regarded as a very beneficial elongation of the mould-board; it certainly is exceedingly useful in deep ploughings when the farmer wishes to plough his land in very shelving ridges, and likewise when he breaks up turf which offers a considerable resistance to the action of the plough, or can only employ one animal to draw the instrument.

Various kinds of coulters have likewise been affixed to ploughs, for the purpose of dividing and cutting the slice before it is separated and turned over by the plough; and these have been affixed to the beam by means of a piece connected with it. On tenacious soils this addition may be productive of benefit; but as I have never yet made any trial of it, I cannot venture to assert that it will not also be attended with some inconveniences.

Ploughs having a moveable or sliding mould-board which can be shifted alternately from one side of the sheath, or head, to the other, have the advantage of being able always to throw the earth on the same side, and, consequently, of ploughing the land flat without any inequality or trace of ridges or furrows. When the first furrow has been traced and the slice turned over to the right, the mould-board is shifted to the opposite side; and thus the second furrow is traced close by the side of the first, and the slice of the second rests upon that of the first. These ploughs are constructed in various ways: the mould-board is often united to the board which closes the left side of the plough, and forms with it an angle of about forty-five degrees, the apex of which is in front of the throat or neck; these two boards are fixed there by means of a moveable peg or pin, and, at their hinder end, are held on by means of an iron bow, which keeps them at a suitable distance. By means of this arrangement, one or other of these boards can alternately be put in action by pressing the contrary one against the head; and they are maintained in their proper position by an iron bolt which is placed in one of the holes bored in the bow. Ploughs of this kind can likewise be employed for the purpose of making furrows for draining by placing the two mould-boards at an equal distance from the head, so that they shall raise an equal quantity of earth.

But, in general, the mould-board of this kind of plough is detached, so that it is when necessary to alter the position it can be removed altogether; although only affixed to the plough by means of hooks, it is yet sufficiently firm.

Occasionally, ploughs of this kind have only a little ear instead of a mould-board, and that is curved and turned in various ways, and, consequently, throws the earth more or less to the side. It will easily be understood without the necessity of my making any remarks on the subject, that by this contrivance the soil is very imperfectly turned over; besides, such ploughs require to be constantly inclined to one side. All ploughs of this kind ought to have a share with two sharp edges similar to those of an iron lance.

In the best of this kind, in those by means of which the land can be ploughed to a certain depth, the coulter is so contrived that the blade shall be able to turn to the right or the left as may seem best. The manner in which this is effected varies in different instruments; but in all those that I have seen, it appears to be liable to frequent alterations and injuries, so that, in general, it accomplishes the purpose it is intended to effect but very imperfectly.

It is, in general, almost impossible to render these ploughs very straight or even on the side which comes in contact with the unturned soil, and yet that is a very essential point as regards the firmness and regularity of the motion of the instrument. The friction attendant on their action is therefore very great, and, consequently, when persons assure us that these ploughs move very easily, and do not require any very great draught power, we are necessarily led to infer that they can only have been used on light soils, and for very superficial ploughings. I have not as yet seen any plough of this kind that acts well, excepting the Mecklenburg *binot*; I therefore always prefer this instrument, on account of its simplicity. Ploughs having moveable mould-boards are very much used in countries in the neighbourhood of the Rhine.

At various periods, public attention has been called to double-furrow ploughs having but one beam, to which are attached two shares and two bodies; these are drawn by one team, advanced parallel with each other, and are guided by a man stationed behind. Latterly, two ploughs of this kind have been presented to the public—one invented in England by Lord Somerville, and the other executed at Vienna. I have an instrument of this nature which was made in England, and is very similar to Lord Somerville's.

It is evident that this kind of plough must necessarily require a moving power considerably greater than that which would be sufficient to draw a more simple plough;

and, consequently, it can only be productive of any saving when the team ordinarily used has more draught power than is requisite to put in motion a common plough. This certainly may occasionally happen; but when, as is generally the case, the double plough requires four horses instead of two, nothing can be gained, because two men will likewise then be required, one to guide the instrument, and the other to drive the animals.

I have several other objections to adduce against the instrument which I possess, although it is very well constructed. It is very difficult to manage when it becomes necessary to turn it at the extremity of the furrow: it cannot easily be made to enter the soil; and, in fact, when the ground is hard this becomes almost an impossibility; besides, the weight of earth which rests on the two mould-boards inclines the plough so much towards the left, that the whole strength of the ploughman's right arm is not sufficient to keep it in its place; and thus the right hand body only turns up the soil very superficially, or is not fixed in it at all: these circumstances have induced me to give up the use of the instrument altogether.

Trenching ploughs, on the other hand, have two bodies placed in a line with each other, but the one working four or six inches deeper than the other. The front one is generally higher, smaller, and weaker than the hind one: it only pares or skims off the surface, separating a slice of earth, and turning it over into the furrow made by the main body of the instrument; the hinder plough raises another slice, which it takes from beneath the place which has just been uncovered, and places it on the slice turned over by the first plough; and thus the whole depth of the furrow is thoroughly turned over. I have often made use of a plough of this kind which was manufactured in England, with all possible care and attention, and in which there was no want of hooks or joints to connect the parts with each other; but the greatest depth to which it could be made to penetrate in land of a moderate stiffness was seven inches, and the instrument did not appear to be able to bear that amount of pressure which was necessary in order to overcome the opposing weight of earth. On calculating the expenses attendant on this plough, and of the team required by it, I became convinced that I should have obtained results at a much cheaper rate by using a common plough and coulter, to be followed by men provided with spades to dig up the bottom of the furrow to the required depth; an operation of which we shall presently have to speak. Then the ploughings are not required to be so deep; and one plough following the other in the same furrow will produce a similar effect. I cannot, therefore, recommend this expensive instrument, although in many cases, and especially on sandy soils, it may be very useful.

Nevertheless, under some circumstances, and particularly when a clover field has to be ploughed up, or a piece of land which has lain for a considerable period in repose, but not very hard, and which does not require very deep ploughings, this operation cannot be too highly recommended. The slice is cut horizontally through the middle, and its surface is turned over and lies at the bottom of the furrow, where it is afterwards covered by the other half of the slice which is free from weeds. A *trenching* or *cutting plough* is generally used for this purpose, which does not penetrate very deeply, and the upper part of which is only composed of a coulter, a share, and a small ear. But, in by far the greater number of cases, that simple instrument of which I have given an account in my descriptions of agricultural implements, under the name of a *paring* or *skim-coulter-plough*, will fully answer every purpose required. I now invariably use it for ploughing up my clover fields, and I find not only that all the plants are thoroughly buried, but also that the soil is perfectly loosened, and that it is not necessary to bestow a second tillage on the land to prepare it for the autumnal sowings, even when the clover is in its third year, or cattle have been pastured on it. In all other cases the land would require three ploughings; therefore, one crop more of clover may be derived from it when this instrument is used, than could be obtained under any other circumstances.

There is also another instrument of a similar kind, in which the ear which raises the upper part of the slice from the bottom of the furrow, and turns it over, is affixed in the front of the throat by means of a peculiar bar, which enters into the beam of the plough. The English farmers, who consider this to be one of their best inventions, and are quite right in so doing, call it a trenching plough.

That termed the *Preussische zogge* is a very good kind of plough, and somewhat similar to those used in this country, having no wheels, and being, like the binot, supported and drawn by the beam which is suspended to the yoke of the oxen. It cannot be denied that this is a very light instrument, and that its construction renders it able to overcome resistance and diminish friction as much as possible. It penetrates the soil like a pointed wedge, and the lower mould-board throws off the earth very well. It also turns over tenacious soils with great facility, and is peculiarly adapted to them; as for lighter land, it divides and turns it over without forming any ridges or inequalities.

The instrument itself costs little; but as it is very fragile it is always necessary to have twice as many of them as can ordinarily be used, in order that the operations of tillage may not be impeded by the occurrence of accidents. This point might, however, easily be remedied; and if the instrument were constructed with more firmness and solidity, the use of it would become less expensive; but its principal defect, or rather the chief objection which is urged against it, is the great difficulty in guiding it; indeed, it can only be managed by persons accustomed to the use of it. It is almost impossible to introduce it into any district, unless persons can be engaged who have been habituated to the use of it from their earliest youth. If not properly managed it leaves unturned ridges between the furrows, which it only covers with new earth. The inhabitants of East Prussia have reason to be attached to this plough, since it was first introduced among them.

The second class of instruments, by means of which the soil is prepared for the reception of the seed, comprises the *binoirs*. The characteristic difference between binoirs and ploughs consists in the former not having a mould-board placed slantingly on their side: many persons in Germany have imagined that it consisted in the absence of the fore-wheels and wheel-carriage.

The *binoirs* vary in shape and make, equally as much as the ploughs do. The greater part of the Roman ploughs were of this kind, and many such will still be met with in Italy, Spain, and France; but as there are not any of all these binoirs, either ancient or modern, which can surpass ours, I shall content myself with describing them.

The *Mecklenburg binoir* thus far resembles a plough: it partially turns over the soil if guided so as to produce that effect. The following are the parts of which it is composed:—1. A pointed triangular-shaped *iron*, somewhat resembling a spade: this is united to the 2nd part, the *ear*. The earth raised by the iron slides obliquely on to the ear, on each side of which it falls, unless the binoir is held in an inclined position; by means of a slight inclination the labourer can cause the earth to fall on which side he pleases. The handle, or elongation of this ear, passes across the beam, and is there fastened by means of wedges; the under part of the ear rests on the sole of the binoir, or that part which slides along the bottom of the furrow. By means of wedges the ear can be raised or lowered according as it appears necessary that the iron should penetrate more or less deeply into the ground. 3. The *beam* is formed of a piece of wood naturally curved in the proper direction, and which is chosen for this purpose with great care. The hinder part of it rests in a mortice hollowed out for its reception in the head; and the handle, which passes athwart and enters the head a little further forward, keeps it in its place, and serves to direct it. 4. The *head*, the object and form of which will be fully explained in what we have to say respecting the other portions. 5. The *handle,* by means of which the instrument is directed. If it is intended that the binoir should throw the earth to the right during its progress, the labourer grasps the handle with the right hand, and inclines the instrument towards that side. Afterwards, when he is returning, he takes the handle in his other hand, and inclines the instrument towards the left; by which means the earth falls into the preceding furrow, and fills it up. If the binoir has to be drawn by oxen, an elongation is made to the beam by means of a ring and a hook, the foremost extremity of which is affixed to the yoke of the animals so as to allow a lateral motion. On the other hand, if it is to be drawn by horses, which does not however often happen, a shaft is adapted to the extremity of the elongation of the beam, and to this the horses are harnessed. When a pair of horses are to be used, the wheel carriage and fore-wheels of a plough are attached to the binoir. No person who is acquainted with this instrument, and with the manner in which it is constructed, can for a moment doubt its efficacy in tilling the soil, in thoroughly dividing all its particles, and completely tearing up all kinds of weeds; but it turns over the slice but very imperfectly, and has also another fault, namely, it does not move the earth throughout the whole width of the furrow, but leaves a ridge of unturned earth between each, which it certainly covers with fresh mould. I have never seen this instrument in operation without being struck by this defect in its action.

All good agriculturists in Mecklenburg agree that the binoir is not adapted for all kinds of operations; and that, especially when pasture grounds are to be broken up, or fields tilled that have borne any kind of grain, all other ploughs are to be preferred. On the other hand, it is peculiarly adapted for the second or third ploughings given to such land; and also for that tillage which precedes the sowings, when the seed is deposited in open furrows. In the latter case, the following is the only inconvenience attending its use: the ox on the right passes over the newly tilled land, and treads it down with his hoofs; and thus holes are formed in which the seed collects. Judicious agriculturists will avoid this inconvenience by making use of the binoir with a wheel-carriage attached to it, and causing the ox to walk in the furrow. Land should never be tilled with a binoir in the same direction with the preceding ploughing, but always in an opposite direction; by this means the binoir cuts through and divides the slices turned over by the previous operation. It is a very good plan to use the plough and the binoir alternately on tenacious soils, provided that a harrow with teeth projecting forwards is likewise used. It is on this account that the operation of ploughing is always so neatly performed at Mecklenburg; in fact, it is scarcely possible to find a garden in which the soil is more thoroughly loosened, cleaner, and neater, than it is in a Mecklenburg fallow. The only inconvenience which I can discover, attendant on the alternate use of the plough and binoir, is, that it is scarcely possible to get the same men and cattle to work with both these implements. Persons not accustomed to the use of the binoir, find great difficulty in managing it; while those who are habituated to guiding it, can frequently work with it for ten hours without being fatigued. It is also hardly possible to employ the same draught cattle, and especially oxen, to draw a plough and a binoir alternately, because, in the use of the former, the right hand ox walks in the furrow, and, when working with the latter, it has to pass over the newly ploughed soil immediately at the side of the furrow: when the instrument is turned, the ox on the left will have to walk over the ploughed land, while the other passes over that which is untouched. Whenever it is practicable to have a separate set of men and beasts for each of these implements, the alternate use of them will be found to be attended with manifest advantages.

The binoir is best adapted for soils of a moderate degree of consistency; on very compact and tenacious land, the use of it is attended with considerable labour and difficulty, and a tolerably good plough is far preferable.

This instrument is apt to divide light soils too much, and to render them too loose and friable.*

The facility and promptitude with which the binoir may be turned aside or lifted up, renders it peculiarly adapted for the tillage of stony land, or that in which there are many obstacles to be avoided or overcome. This instrument is the best that can possibly be used for the purpose of ploughing abrupt declivities or hilly ground; and is far more convenient than any other kind of plough, because it turns the soil over much easier on the side of the declivity, without throwing it too low. Land may be ploughed with it in any direction, whether horizontally or obliquely, up or down hill, and even in a circle round any obstacle which cannot be overcome.

The *Silesian binoir* (der Schlessische Ruhrhaaken), as may be seen by the various descriptions of it which have been published, varies much in its form. Many of the binoirs in Silesia are very similar to that which I have just described. But it is not of those I would speak, but of others, which, instead of the sole that slides over the ground, have only a spade-shaped iron, by means of which they turn up the soil; and two handles behind, for the purpose of guiding them.

The only use of these instruments is to alternate with the plough, for the purpose of breaking up the soil across the ploughings, and for this purpose they are perfectly well adapted.

The *Livonian binoir* is an implement which acts on the soil by means of a bifurcated iron, which, being curved forwards, penetrates the ground with its two points, and loosens it. Another shovel-like iron, placed at the end of a handle, and which resembles in its shape those which are used to cleanse ploughs from dirt or mud, only being a little larger, serves to throw the earth a little on one side. This latter piece is fastened by means of a pin, and may be turned either to the right or

* A full and detailed account of the Mecklenburg binoir is given by *Schuhmacher*, a man to whose researches the science of agriculture is very much indebted, in his work entitled, "Abhandhung vom Haaken als cinem vorzuglichem Werkzeuge anstall des pfluges". Berlin. 1774.

to the left, according as it is requisite to throw the earth on one side or on the other. If we except these two pieces, this plough does not contain any portion of iron; there are no hooks, and the whole is fastened to the pole to which the horses are harnessed, by means of cords.*

One circumstance relating to this binoir, which renders it exceedingly hard work for labourers who are not accustomed to the instrument, is that the hinder part requires a great deal of leaning or pressure, without which it penetrates too deeply into the soil.

The *cart binoir* is an instrument which runs on wheels, and when once entered into the soil, requires no guidance; in general, the labourer mounts upon it or upon a horse, and thus goes forward with it. It is chiefly used in the low countries in the neighbourhood of the Vistula, and is far better adapted for the cultivation of flat alluvial soils than any plough. This instrument is not, however, adapted for breaking up land which has been pressed down and hardened by waggons; such, for instance, as can easily be tilled by one of Baily's ploughs, drawn by a pair of oxen; and if not adapted for breaking up argillaceous soils, it is perfectly useless, for the Mecklenburg binoir is fully capable of performing everything that is requisite for the subsequent tillage.

The third class of agricultural implements comprises those by means of which the soil is not turned over or ploughed very deeply, but is well cultivated to a depth of three or four inches, and with great saving of time and labour; by means of which the soil is thoroughly pulverized and mixed to that depth, and the seeds of all kinds of weeds destroyed, by being in the first place brought to the surface and made to germinate, and subsequently destroyed, and the roots of other weeds torn away or killed, by being cut in pieces. It is not until latterly, that this class of instruments have become known to us. We are chiefly indebted to the English for the

* A description of this instrument will be found in the work entitled, "Anzeigen der Leipsiger Œkonomischen Societen von der Ostermesse des Jahrs," 1804, A.

discovery and invention of them; indeed, the mechanical talents and ingenuity of that nation have tended very materially to improve the science and practice of agriculture. There is a great variety of these instruments used in England. Every farmer employs the one best adapted to the nature of his land, and to the end which he has in view. Occasionally he makes such alterations as seems best to him in their construction; but these modifications are seldom of any great importance. All those persons who invent or improve such instruments, almost always name them afresh; and it not unfrequently happens that the same instrument will receive a different appellation in each district where it is used. We must not, therefore, imagine, that because we hear it lauded under another name, that it is a different kind of instrument. If we wait until we can see or obtain a circumstantial description of it, we shall generally find that it differs very little from those we are already acquainted with. The different instruments appertaining to this class may be ranged under the following denominations.

1. *Scarifiers.* In general, these instruments are armed with curved knives, somewhat similar in form to the bill-hooks or pruning knives used by gardeners. These knives are affixed to bars passing across a wooden frame, resembling that of a harrow: they are not arranged behind one another, but in such a manner that each one shall trace its own line separate from any of the others. The chief use of scarifiers is to penetrate the soil and divide it to a certain depth, and to cut through argillaceous soils, and loosen them more deeply than a harrow could, and turn up the under portions and bring them in contact with the atmosphere. Cattle are occasionally harnessed to the instrument itself; but in general a wheel carriage and fore-wheels is affixed to it, and two handles are attached to the back in order to weigh it down and cause it to penetrate the ground. At other times, small wheels are added to each of the angles of the scarifier, which can be raised or lowered at pleasure,

so as to give the instrument a greater or less tendency to enter the soil.

The same frame may be made to receive other irons; for example, an extirpator may be transformed into a scarifier, by substituting the knives which constitute the latter, for the shares or feet which belong to the former.

2. *Horse-rakes, scrapers, levelling ploughs.* I give them this latter name, because they act on the soil in the same way as the blade of a plane, by cutting the earth horizontally to a depth of one or more inches below the surface, and dividing it. Those who are acquainted with the common horse-rake, which is used to keep the walks and alleys of large gardens clean, will be able to form a very correct idea of this class of instruments. The blade may be rendered more or less oblique, according as it is deemed requisite that it shall penetrate the soil to a greater or less depth. The frame to which the blade is attached, is supported by two handles, and the foremost part of the beam usually rests upon a wheel: sometimes the fore-wheels of a plough are affixed to these implements. They are chiefly used for the purpose of clearing from the ground the stubble of corn crops, and tearing up the weeds which spring there. They are also used for the purpose of levelling land in which the earth has been heaped up round the roots of the plants which formed the last crop. They are principally used for this purpose in the county of Kent, where they are employed to give a certain degree of tillage to land after the bean crops have been gathered, and to prevent the soil from becoming infested with weeds during the period which has to elapse before the proper time arrives for ploughing it, previous to the sowing. This operation may be performed very quickly, and does not require any very great degree of draught power. By means of it the soil may be prepared in a very short time for the reception of spurrey, buck-wheat, radishes, &c.; because it frequently happens that at a

certain depth below the surface the earth is tolerably loose and light, and it is only the surface which requires to be divided.

3. *Hoes.* The instruments which are comprehended under this denomination, act on the soil by means of feet, teeth, or shares, more or less pointed or obtuse, and more or less horizontal or inclined, and which are shaped like a shoe or a goose's foot. They are intended to loosen the whole surface of the land over which they pass; and for this purpose the tines are arranged in two or three lines, so that no particle of the soil shall escape them, but every portion be thrown by the front row of teeth into such a position as not to escape the action of the hinder ones; and thus each clod may be repeatedly acted upon and broken. The *extirpator*, an instrument which is now very much used, and of the utility of which every practical agriculturist must be convinced, belongs to this class. This instrument may be made of various sizes. Where the land is very even, the number of feet on every rail may be increased: thus, six may be affixed to the back row, five to the front, &c. But where the land is unequal, it is better to make use of a narrower extirpator, and which has not so many tines. The draught power must, of course, be proportionate to the size of the instrument; and if four, or even six horses are requisite to put in motion a large extirpator, two will suffice for a small one. The more tenacious the soil, the more pointed must the tines be. It is also advisable to make the front row, those which are to open the ground, sharper than the hinder ones. The irons may be rendered flatter or more convex, or may be so constructed as to have several diverging points, according as the instrument is intended merely to move the land, or to divide it thoroughly and turn it over. The depth to which these tines shall penetrate the soil, may be regulated by raising or depressing the beam. In my opinion, the tines in the front row ought to be, at least, half an inch longer than the hinder ones, in order that they may penetrate more deeply into the soil, even when the beam is not raised.

Without this precaution they do not enter so far as the hind ones, and frequently only slide along the surface.

There are few soils which will not be benefited by the use of this instrument. Several persons who have employed it with great advantage, have assured me that when the tines or shares are sufficiently pointed, it penetrates easily, even into the most tenacious soils. The only places in which it cannot so well be used, are those where the surface of the ground is full of large immoveable stones. When employed on such soils, care must be taken that the tines or shares do not break, or, at any rate, that others shall be at hand to replace those which are injured, and also that the points shall be strong enough to enable them to resist the action of four horses. Small stones will not impede this instrument, even should they be too large to admit of their passing between the irons; all that is requisite to be done here is for the conductor to stop the cattle for a moment, and throw the stones on one side. It cannot, however, be denied that stony land wears out the shares very soon. On land overgrown with couch grass, or which contains undecomposed lumps of turf, or potato haulm, or other things of a similar nature, the action of this instrument is certainly impeded; but still it can act, although not without labour and difficulty. In such cases, the labourer must lift up the extirpator now and then, and shake it well; or, should this not be sufficient, he must stop and clean it—an operation which is very quickly performed by means of an instrument similar to a small shovel, and which is also used with the plough.

The use of the extirpator is so beneficial, that it not only supersedes all ploughs which bestow a merely superficial tillage, but surpasses them in their effects, whether as regards the division of the soil, the effecting of an admixture of its component parts, or the cleansing it from weeds: it is from its great utility in the latter capacity that it derives its name. Besides, with an extirpator having six tines in the back row, and drawn by four horses, and driven by two men, equally as much work can be done as would be effected by six ploughs, each drawn by two horses and driven by one man, and often more, because an extirpator moves more quickly than a plough. It is therefore evident that the use of this instrument is attended with very great saving. When a piece of ground has been turned up to the requisite depth by a plough, the extirpator may be used with advantage for all the subsequent ploughings bestowed on it, and a more complete fallow, and more free from weeds, will thus be obtained than could possibly have been procured by any other means; provided that this instrument is used in time, and the weeds have not been allowed to gain too great an ascendancy. Besides, an extirpator distributes and smoothes land much better than a plough, raising and dividing the soil on eminences, and with the assistance of a harrow subsequently spreading these portions over the hollows and lower spots: this effect is peculiarly apparent when it is alternately used in every direction. The extirpator may also be used for the purpose of burying the seed; but there is another instrument, of which we shall presently have to speak, which is better adapted for this purpose. Provided that the land is tilled before the commencement of winter, the extirpator is fully capable of bestowing on it every preparation for the reception of the seed of any kind of grain, and especially of barley. By its action, the soil is pulverized to the requisite depth, and the necessary portions of nourishment brought within the reach even of the smallest of the germs. Land tilled in this way retains its moisture much longer than it does when the plough only is used — a point of no small importance in dry spring weather.

If a sufficient period is suffered to elapse between each of the operations of tillage bestowed by this instrument, those seeds of weeds which were enclosed in the clods broken by the first operation will germinate, and the plants produced by them acquire sufficient development to admit their being torn up and destroyed by the second. The roots of weeds are also brought into contact with the air and

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If a sufficient period is suffered to elapse between each of the operations of tillage bestowed by this instrument, those seeds of weeds which were enclosed in the clods broken by the first operation will germinate, and the plants produced by them acquire sufficient development to admit their being torn up and destroyed by the second. The roots of weeds are also brought into contact with the air and destroyed by being repeatedly torn and cut. The utility of this instrument becomes strikingly evident when land which has borne weeded crops, for which it received the proper ploughing and cultivation, is, on the following spring, to be prepared for the reception of oats. By means of it, I have been able to succeed in raising good crops of large two rowed barley, from very sandy land, on which this kind of grain could not possibly have succeeded if it had been sown in the spring after a single ploughing. The extirpator may also be employed with great success on a broken up clover field, where one ploughing has not been sufficient to divide and loosen the soil. When this instrument cannot be used, three separate ploughings must be bestowed on such land, which necessarily tend to retard the sowings. The extirpator is fully capable of loosening a soil, and rendering it sufficiently friable, and will likewise destroy the roots of the clover.

Nor is this instrument conducive of less benefit to land which has been ploughed up after bearing a crop of peas or vetches. It is well known that such land should always be broken up immediately after the crop has been gathered in; and, likewise, that it is then liable to become hard and infested with weeds, if not tilled a second time; but every moment is too precious to admit of time to plough it again. By means, however, of the extirpator, the surface may be renewed, and the soil so thoroughly loosened, that it is ready for the reception of seed, without the necessity of any other preparation.

Lastly, I have derived considerable advantage from passing this instrument lightly over a field of potatoes, when these plants were just shooting up and bearing a few leaves. This operation destroys the weeds which have sprung up there, and causes the crop to be less infested with parasitical plants. Many persons have considered that this end is attained equally well by the use of the harrow, especially if, after having planted the potatoes with a plough, the soil is left in the condition to which it was reduced by that implement. I agree with them that the ground should always be harrowed directly after the crop is sown, in order that the germination of all the seeds and roots of weeds that it contains may be facilitated, and that they may shoot up sufficiently high to admit of their subsequently being destroyed by the action of the extirpator. It is generally admitted that this operation cannot be performed when the potatoes are planted on narrow and raised ridges.

Various implements, furnished with teeth or prongs of different shapes, or shares, have been invented in Germany, for the purpose of cultivating and tilling the soil to a greater or less depth. These are constructed in various shapes, and are of different sizes; some being armed with large wide irons, others with small narrow ones, and having three, four, five, and even six rows of them. Some have a wheel carriage attached to them, while others are drawn by means of a stiff pole. D'Arndt, a man celebrated in this country for the superior skill and excellence with which his fields are sown and cultivated, makes use of several instruments of this kind.

The most celebrated agricultural instrument invented by D'Arndt, is the *sowing plough (saatpflug)*, which produces an effect similar to that of the small English extirpator. The shares of this instrument are generally four in number, and formed like common ploughshares; they are fixed to iron legs, which are attached to bars about eight or ten inches apart. The beam passes through these bars, and, like that of the extirpator, is adapted to a wheel carriage, on which it can be raised or lowered, according as it appears requisite that the shares should enter deeply or superficially into the earth. At first, D'Arndt had appended small mouldboards or ears to each of these shares, in order by this means actually to plough the land and turn it over. But he subsequently became convinced that it was better without an addition which tended greatly to increase the amount of friction and resistance, and to clog the instrument with weeds and clods of earth, without communicating to it the good qualities of a plough. This instrument is chiefly used for the purpose of burying the seed in land already tilled and prepared, and it is fully capable of effecting this purpose in the most complete and perfect manner. After the seed has been spread over land previously well harrowed, this instrument is so regulated as to cause it to penetrate to a depth of about two inches below the surface, and is then passed over the whole of the field. This is a very laborious operation for two horses and a man, but the seed appears to be better distributed than it is by any other means with which I am acquainted. After a slight harrowing has been bestowed on the soil, the seed will be found to be placed at a suitable depth beneath the surface of the ground, properly mingled with the soil, perfectly divided, and not laid in heaps or hidden under impenetrable clods, but placed in the situation most favourable to the development of its germ and the extension of its roots. Thus, therefore, by means of this sowing-plough at least one quarter of the quantity of seed otherwise required will be saved; many persons have assured me that it saves more than the half; besides, this instrument does the work of four ploughs with far less labour, accelerates the operation of sowing, and enables the farmer to choose the most propitious moment for the performance of it. I must, however, state that I have not yet used one of these implements, because my land is not sufficiently free from weeds to admit of my employing it with advantage.

The English have a great many implements of this kind, differing in form, but productive of similar effects. In order to divide tenacious soils better, and facilitate the entrance of the shares into the ground, a knife or coulter is sometimes placed before each of them, or knives and shares are made to alternate. Some of these instruments are so carefully and ingeniously contrived, that the shares can be moved further apart or nearer together as occasion may require; but where this is the case, the mechanism becomes more complicated and the instrument more fragile.

Great care must always be taken to choose from this variety of instruments those which are best adapted to the end which it is proposed they should attain, and to the soil and circumstances of the undertaking on which they are to be employed. It is very ill-judged economy to refrain from the purchase of such as are calculated to fulfil the proposed end in the best possible manner; it not unfrequently happens that the advantages arising from the employment of them are so great that their cost is repaid in the course of the very first year, nay, sometimes in the very first season.

This observation applies particularly to the sowing-plough, which more than repays its original cost by the quantity of seed which it saves. It will hardly be believed that there can be among agriculturists men of such narrow minds, or who are so little sensible of their actual interests as to grudge the sum which such an instrument costs, although fully sensible of all the advantages arising from the employment of it; or authors so blind and bigoted by prejudice and avarice as to defend and advocate such niggardly and futile policy. The poorest mechanic does not hesitate to purchase the tools adapted to his art as soon as he becomes convinced that it will tend to facilitate and improve his labour and render the fruits of it more perfect.. It is such contracted views as these which retard the progress and perfection of the noble science of agriculture, and debase it below the level of the meanest art.

Harrows.

Harrows constitute a second class of instruments which are indispensably necessary in the tillage of arable land; and without which the plough would cultivate the soil but very imperfectly.

These instruments are also made of various sizes and forms, as, of course, they must be, in order to enable them to fulfil all the different purposes for which they are intended. They are divided into two classes; the *heavy* harrows, or those which are drawn by two, four, or six horses; and the *light* harrows, of which a single horse can draw one if not two.

The large harrows are composed of strong bars of wood, connected together by cross bars morticed into them, and armed with long iron teeth or prongs, each of which weighs one or more pounds. This class is chiefly used for the purpose of breaking the furrow slices of a turfy soil that has been turned over by ploughing, or for the purpose of breaking and dividing the clods on tenacious soils: they are quadrangular or triangular in form. In the latter case, these teeth or tines are sometimes shorter towards the foremost angle of the harrow, or that to which the draught power is attached, and increase in size at each row, so that the hindermost row contains the largest. Handles are occasionally added to the hinder part of the harrow, by means of which it can be raised up or forced deeper into the soil; the teeth are either perpendicular, or inclined with the front forwards, or curved forwards like a bill-hook.

The teeth of small harrows are either formed of wood or iron; indeed, there are some in which a tooth of wood and one of iron are placed alternately. Many agriculturists have altogether rejected harrows having wooden teeth as wholly inefficacious; there are, however, circumstances under which the use of them will prove advantageous not only on sandy soils, for which they are peculiarly adapted, but also on heavy land; which, although tolerably well divided, still contains a great number of clods. On such land it is much easier to expedite the motion of wooden harrows than of those of iron, and the suddenness of the stroke tends more to break the clod than the weight of the instrument or the material of which it is formed. Wooden harrows are likewise preferable to iron ones for the purpose of covering small seeds, or of bestowing a slight cultivation on land in which the plants are just shooting up, or for smoothing and equalizing the surface of a soil where it is not necessary that the teeth should penetrate to any depth. There are, however, many persons who make use of wooden harrows for the sake of economy, when iron ones would be far preferable.

In the variously shaped small harrows the teeth or prongs are sometimes fastened in in a perpendicular, at others in an inclined, position: where the latter is the case, the instrument may be used either for light and superficial, or for deep and heavy harrowings, as may seem requisite. When the draught power is attached to the instrument in such a manner that when it moves forward the points of the teeth incline towards the front, these will penetrate better into the soil and produce a greater effect; but, when turned in an opposite direction, their action is less sensible, and they often merely glide over the surface of the soil and scarcely disturb it. The teeth or prongs of a harrow are very seldom round, but, in general, of a quadrangular or triangular shape; this latter form is most preferable, because the angle is more acute; they are also occasionally shaped like coulters, with a sharp edge and a broad back.

There are various ways of fixing these teeth or prongs in the harrow; sometimes they are inserted into the balls or beams by being driven in like a nail; and at others they are merely rivetted on, or fastened with nuts or screws. In the former case, it is necessary that they should be made of a greater length, in order to allow their being driven in sufficiently far to render their hold firm, and yet a sufficient length remain outside to admit of their being sharpened when the point becomes blunted. But teeth thus inserted are very apt to be lost: the striking of a harrow against a stone will frequently serve to knock one or more out; and they are not unfrequently pulled out by persons who happen to require a bit of iron for a bolt, or for any other purpose. Those teeth which are most firmly attached to the harrow are nailed on to the frame or beam, after having been previously rivetted into a bar of iron: those which are shaped like coulters are frequently fastened on with screws, in order that they may be taken off whenever it becomes necessary to sharpen them.

The following are the chief points necessary to be attended to in a large harrow, if we would have it perfectly fulfil all the purposes of tillage for which we intend it:—

1. The teeth should be at a sufficient distance from one

another to admit of the earth passing between them, and to prevent it from gathering into heaps.

2. They should be so arranged that the furrows which they have to trace in the soil shall be at equal distances from each other.

3. Each tooth or prong should trace its own particular line, and one not fall into, or become confounded with another.

4. The rows of teeth should be as nearly as possible at equal distances from each other, in order that all parts of the instrument may act with equal power. In by far the greater number of harrows the third essential point is overlooked: the teeth are disposed angle-ways, so that those in the third row fall into the lines traced by those in the first row, and those in the fourth into the lines traced by the second row; thus, one portion of the teeth is absolutely useless, for the clods acted upon by the first row are either broken or thrown on one side, and, consequently, are not touched by the other teeth. Another inconvenience also frequently arises from several rows of teeth falling into the same line, too deep a furrow is formed; for example, when land is harrowed after having been sown with very small seeds, the defect just alluded to is very apt to cause the seed to be buried too deeply. This defect might be in some measure remedied by attaching the draught power a little towards the side of the front beam instead of exactly in the centre, so that the body of the harrow, not being in a right angle with the traces, may move in a sloping or diagonal direction. The lines thus drawn will receive a different direction, and be less liable to run into one another; but where this is done, that portion of the soil over which only an angle of the harrow passes will be less perfectly tilled than any of the rest, and it will be necessary to cause the instrument to go over it again, whereby the amount of actual labour is increased. This inconvenience is less sensibly felt in circular harrowing, because the instrument is then passed several times over each portion of land. In those districts where the farmers confine themselves to longitudinal

harrowing, it is highly requisite that the teeth of the instrument should be so arranged that each may trace its own distinct line; and also that these lines shall be at equal distances from one another.

In some harrows the draught power instead of being attached to either of the sides is affixed to the point or angle; such instruments, especially when their teeth are curved forward, have a starting or jumping motion which contributes greatly to break the clods and divide the soil. The regulator, by means of which the draught cattle are harnessed, is moveable, and, therefore, favours this jerking motion; but in this case the harrow must necessarily pass more or less over the part which it had traversed before. When these harrows are small but heavy, and provided with strong teeth, they are productive of material benefit to strong heavy soils, especially when driven over these at a brisk trot. The form of a harrow is usually that of a square, the sides of which are sometimes equal, and at others unequal in length; and the draught power may be attached either to the length or to the width: there are frequently five beams in the length, but only three in the width. Some harrows are of a triangular form, and then the draught power is attached to one of the angles.

In those places where the land is ploughed in elevated ridges, and where it is only harrowed longitudinally, a large, stiff harrow will not be able to act upon the whole surface of the ridge. An instrument divided into two parts which are united to one another by means of rings, hinges, or little chains, so that half inclines on each side of the summit or crown, is therefore used. Where the ridges are all of equal width, two, threc, or sometimes four harrows are thus joined together, so that the whole width of the ridge is tilled at once. The draught cattle are attached to these by means of a common spring-tree bar affixed to the middle, and the horses walk in the centre of the ridge, or a horse is harnessed to each extremity of a pole or beam, which is as long as the ridge is wide, and these animals walk in the open furrows on either side; this is by far the most preferable mode of proceeding on damp, wet soils. This pole is affixed to the harrows by means of chains proceeding from it to each of the instruments, which are thus all put in motion at once. Should the ridges be raised so high above the furrow that the pole just mentioned is in danger of rubbing against the crown of them, an axle, mounted on wheels, and stretching the whole breadth of the ridge, is then made use of; these wheels pass along the open furrows, and ought to be of sufficient height to keep the pole or axle from coming in contact with the ridge. This is a rather complicated arrangement, but one that is very beneficial, especially where moist, wet land has to be harrowed after the sowing has taken place, as it prevents the cattle from passing over the ploughed land and treading it down; it is well known that on soils of this nature the seed seldom springs up in those places which have been trodden down by the feet of cattle.

In those places where several horses are always used in harrowing, these animals are placed in a slanting position, so that it shall only be necessary to lead the first, and all the others shall be forced to follow in the same direction. To effect this, the straps of the bridle of the second horse are attached to the trace-bar of the first, those of the third to the second, and so on. By means of this arrangement it is much easier to keep the horses in the required position.

Harrows ought always to be provided with sledges on which they can be transported to and from the fields. These sledges are also useful for the purpose of conveying the swing-ploughs to and from the land on which they are to be used. As the harrow is a very important implement, and one that cannot be dispensed with, and as, moreover, it forms a very considerable item in the expenses of an agricultural undertaking, all possible care should be bestowed on it; when not used, these instruments should be kept under cover, and, whether in the farm-yard or in the fields, should never be suffered to lie on the ground, but always raised and propped one against another.

Harrows are sometimes provided with branches or bushes, and for this purpose several frames, consisting of three or more cross-beams without teeth, are kept; this kind of harrow is very efficacious when it is only necessary to level inequalities and break those clods which have escaped the teeth of a common harrow. They are likewise used for the purpose of burying small seeds, as clover, &c. The bushes used for this purpose should be strong and elastic, but not too thick, or placed too close to each other, or they will be apt to form furrows and carry away the seed which they should only bury.

Some persons make use of harrows formed of branches interlaced and woven like basket-work, and speak highly of the efficacy of such instruments.

It is a point of the greatest importance that the operation of harrowing should be properly performed, and at the fitting season; where such is not the case, the inconveniences resulting cannot be compensated by any care or perfection of tillage. The extirpator is the only instrument which can supersede or diminish to any considerable degree the use of the harrow.

The operation of harrowing may be divided into the following varieties:—

1. *Longitudinal harrowing*, or harrowing in the same direction with the ploughing.

2. *Cross harrowing*, or intersecting the ridges and furrows formed by the plough.

3. *Serpentine harrowing*, or turning the harrow alternately from one side of the ridge to the other, and thus making it describe a line somewhat resembling two figures of eight placed one under the other $\frac{8}{8}$.

4. *Round harrowing*. As this highly efficaceous mode of harrowing is but little known in most countries, I shall enter into a more circumstantial description of it. It can be practised as well in those places which have been deeply ploughed, and where the ridges are high and wide, as it can on those which are ploughed as evenly and uniformly as possible. The horses, of which there are usually four or six, are harnessed in the way before described,

some to the trace-bar, others to the harrow. The driver takes hold of the front horse on the left, by the bridle, and makes him walk round him. The other horses must, as may easily be conceived, describe a larger circle the further they are from the centre. When the circle is almost complete, the man proceeds a few steps further and repeats the same evolution; and so on, until the whole surface has been passed over by the harrow. It may easily be supposed that the horse which is furthest from the driver has the hardest work to perform, and, therefore, the weakest and smallest are always placed in the centre, and the largest and strongest on the outside; or else, when they are nearly equal in strength, they are worked alternately first in one place and then in the other. The outside horse is generally obliged to proceed at a rapid trot, even when the centre one is moving as slowly as possible. When the soil is very heavy, and the outer horses are obliged to work at full trot, in order to divide and loosen it thoroughly, they become very much exhausted; indeed, this operation can only be executed by animals full of strength and vigour. It cannot be denied that this mode of harrowing takes up a great deal of time, because every part of the surface has to be repeatedly passed over; but, on the other hand, it produces an effect which could not be obtained from any other method of conducting the operation. Quick harrowings of this description are usually performed with harrows having wooden teeth, because horses could not support the labour occasioned by heavy instruments. When the land has been completely harrowed in this manner, the instruments are drawn over it lengthwise, the rate of going in this case being also a brisk trot. The driver mounts the first horse in order to make him go more rapidly. This operation is best executed in Mecklenburg: there is not, in fact, any other operation of agriculture to which so much attention is paid in that country.

It is even more essential that favourable weather, when the ground contains a proper quantity of moisture, should be chosen for the performance of this kind of harrowing, than it would be for ploughing. If the land is too moist, the harrowing will be very likely to do more harm than good, and to harden and agglomerate, instead of dividing the soil. It is also of importance that the ground should not be suffered to become too dry and hard before this operation is performed, as it is then impossible to manage it. Even when the most favourable season and the most suitable degree of temperature have been chosen, all other agricultural operations must be suspended while this one is in hand. In the table, therefore, of those team labours which are to be executed in any particular week or month, harrowing must always occupy a principal place.

The Roll.

The *roll* is another exceedingly useful agricultural implement; in fact, it is impossible to dispense with it in any complete system of tillage, let the nature of the soil be what it may. We shall, in the first place, examine the various uses to which this instrument is applied. It is, indeed, essential that this examination should be gone through before treating of the different forms given to the roll, these latter being determined by the purposes for which the instrument is to be used.

The first object usually aimed at in the employment of this instrument, is to break those clods or indurated masses of earth which have resisted the action of the harrow; or, at all events, to bury them in the ground, so that at the next harrowing—which when thus buried they cannot well escape—they must, of necessity, be somewhat diminished in size. It is for this reason that in countries where the soil is very tenacious, and tillage very carefully conducted, it is the custom, even after preparatory ploughings, first to harrow, then to pass the roll over the ground, and then to harrow again. In such places, land not treated in this manner would be looked upon as being very badly prepared.

The second object of rolling, is to give a somewhat greater degree of compactness to a soil which is too light and friable, and to unite its component parts. The roll is not employed for this purpose to so great an extent as it might be with advantage; its action, in this case, being highly beneficial, particularly in counteracting the bad effects produced on extremely light soils by the too frequent use of the plough, and likewise in preventing the too rapid evaporation of the moisture contained in the soil. This application of the roll is particularly resorted to on the spongy soils of valleys; in such situations, indeed, it cannot well be dispensed with.

The third use to which the roll is applied, is to press down and make firm the ground about newly-sown seeds, and to cause the latter to adhere better to the soil. Sometimes, when very small seed is to be sown, it is found advantageous to pass the roll over the ground before the seed is sown, so as to level it thoroughly, and facilitate a more equal distribution of the seed than could otherwise take place. Where the ground has been thus levelled, those seeds which happen to fall together, separate from each other; and it is seldom that two are found lying in one spot. The harrow is then passed over the ground; and this operation is followed by repeated rollings, which obliterate the lines drawn by the harrow. The roller may also be employed with advantage on soils which are neither particularly moist nor tenacious, after the harrow has been used to cover the seed. This operation serves to press the earth more closely into contact with the seed, which then germinates and springs up with much greater rapidity. The truth of this will be plainly seen by observing those parts which have escaped the action of the roll; for there the seed does not spring up so quickly as it does where the ground has been well pressed by this instrument. Probably, too, the pressure may, by the greater compactness which it gives to the soil, prevent any rays of light from penetrating, and thus interfering with the process of germination. Another advantage derived from this levelling of the soil by the roll is, that the harvest is greatly facilitated; for it enables the labourers to reap or mow closer to the ground, a point of great importance, especially as regards the pea and bean crops.

The fourth great use of the roll is to cover with mould, or press against or into the ground, the roots of those plants sown in the preceding autumn, which have been detached by the frost. Soils rich in humus, such as those found in valleys, sometimes swell up in the spring to such a degree that the roots of the plants contained in them are forced up. In such cases, if a fall of rain does not speedily occur, the roll affords the only means of restoring them to their proper position.

Lastly, the roll is sometimes employed for the purpose of destroying insects which injure the young plants, and which, particularly during the night, come up to the surface to seek their food. When applied for this last-mentioned purpose, the operation of rolling should always be performed after the close of day.

The roll is moved by means of a frame or carriage, in which the two extremities of its axis are fixed. The roll itself is generally round, but varies greatly both in length and diameter; and the shorter it is the more powerfully does it act. Increase of length, far from adding to the amount of pressure, actually detracts from it, by causing the weight to be sustained on a greater number of points of the surface at once. The usual length of the cylinder is from six to nine feet: the diameter varies from one to two feet.

Hexagonal and octagonal rolls are also in use. They are much more efficient for the purpose of breaking clods than round ones; because, at each step of their progress, they fall to the ground more suddenly, and move with a less equal motion. But they require greater force of traction than round rolls, which is probably the reason why they are so little used. I consider that they are capable of producing highly advantageous effects on tenacious soils.

With the same view, rolls are sometimes made with

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grooves or flutings; but if the soil on which they are used is not very dry, these flutings and spaces become filled with mould, and the efficacy of the roll is of course diminished.

The carriage of the roll is made in various forms, none of which appear to me to possess any great advantages over the others; I refrain from giving any description of them, being fully persuaded that all my readers must be acquainted with some one among the number. The only particular which positively demands attention is, that the carriage should be so constructed as to admit of the driver's sitting upon it. That he should do so is desirable: first because the weight, and consequently the effect of the roll, is thereby increased; and, secondly, because the cattle can then be driven at a brisker pace, provided that the labour does not fatigue them too much. Another advantage attending this arrangement is, that it protects the driver from the annoyance of the dust, to which he would otherwise be exposed. Rolls without frames are likewise made use of, the extremities of the axles of which turn in rings which are attached to the shafts by hooks. When the direction of a roll thus mounted has to be reversed, there is no occasion to turn the instrument itself, but it is only necessary to take the horses off, unfasten the rings for a moment, and refasten them again, when the shafts and the horses have been brought round to the proper position. This mode of proceeding obviates all those inconveniences produced by the roll dragging a quantity of earth round with it as it turns; an inconvenience which is not, however, so perceptible when the circle described by the roll in turning is rather large.

Some persons use stone rolls on their fields. There, doubtless, are cases in which such pressure on the ground may prove advantageous; it appears, however, to me that in most instances it will be found too powerful, and consequently the use of these very heavy rolls cannot be generally recommended. I have frequently derived advantage from passing a stone roll over a sandy soil soon after its being dug or ploughed up, but this is the only trial of the kind I have made.

Spiky or pointed rolls. These rolls are armed with iron points, the intention of which is to effect a more complete division of the clods; and they are still used for this purpose in many agricultural establishments. Rolls of this description can only be used on very dry soils, and when the proper time for harrowing successfully has been suffered to pass. Where the soil is argillaceous, and likewise contains moisture, it sticks to the points, and becomes so firmly amassed between them that the whole instrument is soon covered with it, and the points cease to be productive of any effect. This inconvenience is less to be feared with rolls which are armed with iron hammers instead of points, the hammers being placed at greater distances from each other than the points. These hammers never fail to break the clods with which they come in contact.

English writers have often recommended the use of rolls armed at intervals with sharp circles or rings, for various purposes, and especially for that of forming furrows in the soil, and for several other uses to which I shall have to revert elsewhere.

It is necessary that a favourable period and weather, when the ground is sufficiently dry, should be chosen for rolling, as for harrowing. It is absolutely necessary that the humidity of the soil should not be so great as to cause it to stick to the roll, for when that is the case the operation is likely to prove more injurious than beneficial, not only to tenacious and clayey soils, but also to those which are lighter, inasmuch as it hardens the ground, and forms over it a crust which is impervious to air and atmospheric action. On the other hand, however, it is not right to wait until the clods of tenacious land have, by the evaporation of all their moisture, become so hard as to render the action of the roll on them totally inefficacious.

ON PLOUGHING.

In the performance of this operation it is requisite—

1. That the lines traced by the plough should be perfectly straight, and parallel with one another; the furrow slices all equal, and uniformly turned up, so that they may not overlap each other, or form any inequalities on the surface of the ground. If it be otherwise, that is to say, if the slices are not of equal breadth, the operation becomes more difficult, because at every deviation from the straight line the resistance which the earth opposes to the instrument becomes increased.

2. That the plough advance at a regular and uniform depth, and on a line parallel to the surface of the soil; that is to say, that it do not, as is the case when it is not well guided, sometimes cut thick and at others thin slices.

3. That the plough empty the furrow as completely as possible, so that the earth may not fall in again after the instrument has passed; and that the portion of soil not yet raised, but which has just been divided by the ploughshare, may form not an acute but a right angle with the bottom of the furrow on which it borders.

4. That the furrow-slice be turned up at an angle of about 40 degrees, or so as to form with the surface of the ground, or the bottom of the furrow, an angle of from 40 to 50 degrees; which is in most cases the best inclination.

5. That the divided slices be always of the same breadth; and that it be such as is required by the nature of the soil itself, and the purpose of the operation.

6. That they likewise preserve the depth which it is desirable to give them.

7. That the ridges or heaps of earth between the furrows be of a suitable length and breadth, and that their sides be parallel to one another, so that they may not terminate in a point; for such a form tends to increase the labour of ploughing considerably by rendering it necessary to turn frequently.

8. That the ploughs be placed one after another on

different parts of the land to be ploughed, so that the operation may be executed in the best possible order, and with as little loss of time as possible.

The fulfilment of these essential conditions is secured to a certain extent by taking care that the plough is properly constructed; but it also depends in a great measure on the skill of the ploughman, who must not be actually stupid, or quite a novice in the use of the instrument. The accomplishment of all the other operations is essentially dependant on the skill displayed by the ploughmen in the execution of theirs. This remark replies particularly to the head ploughman, who directs and superintends the operation, it being his duty to see that the furrows are cut with that perfect straightness of which we have already spoken. The selection of the head ploughman is not, therefore, a matter of trifling moment, and it is exceedingly important that this man should have a correct eye.

The inspector of the work should look well that all these things are carefully attended to; it is his special duty to determine the length and breadth of the slice according to the object which is to be attained by the ploughing; and if entire confidence with regard to this matter cannot be placed in the head ploughman, it is the place of the inspector to mark out the distribution of the banks or ridges. We shall see in the sequel what there is to be observed with respect to certain peculiar forms of the plough.

The width of the sod or furrow-slice must be regulated according to the nature of the soil and the object to be obtained by the ploughing. The greater the tenacity of the soil, the narrower should these slices be cut; for when they are too broad, it is impossible to divide and break them properly with the harrow. From a light or sandy soil, on the other hand, wide slices may be cut without any inconvenience, because the harrow always has sufficient power over such land to pulverize it completely.

The greater the depth of the furrows, the less should be their width, both because the plough would otherwise have too much resistance to overcome, and because if the pieces of earth or sods cut out of them are both broad and thick, they cannot be turned over so completely as they ought to be. But when the ploughing is merely superficial, there is no objection to the width of the slices being increased. If the object in view is only to bury stubble, or to turn up the turf of land lying fallow, in order to facilitate its decomposition and disintegration, ploughing-in wide slices is admissible, and, in certain respects, perhaps preferable.

It has already been observed that two or three inches more or less in the breadth of a slice make a great deal of difference in the quantity of work done by a plough. When the object is to divide a tenacious soil very minutely, the most convenient and proper breadth for the slice is six or seven inches; but where the soil is light, an almost equal advantage will be gained by making the slices a foot wide. The length of ground traversed by the plough in ploughing a field is inversely as to the breadth of the slices; that is to say, the length traversed when the slice is seven inches wide, is to that passed over when it is twelve inches wide, as 12 to 7÷; so that (supposing the rate of progress, or in other words, the pace at which the cattle move, to be equal in both cases,) twelve hours are spent in ploughing a field with furrows seven inches wide; while only seven hours would be required to plough it if the furrows were twelve inches wide.

If the mould-board cannot be turned alternately to the right or left of the plough, but is, on the contrary, fixed to the right side of it, the land cannot be ploughed perfectly flat and even; but the ploughed surface must necessarily be divided into banks or ridges, separated by furrows, and elevated in the middle in proportion to the depth of these furrows. The ploughing is said to be *raised* or *flat* according as the ground is turned up in ridges intended to be permanent, or the operation is conducted in such a manner as to keep the surface as equal and uniform as possible.

The surface may be flattened and equalized to a certain extent by ploughing from the edges to the middle of those ridges which had previously been ploughed from the middle to the edges; that is to say, those ridges in which the first two sods or slices have been thrown one against the other.* If the land be ploughed alternately outwards and inwards to the same depth, the banks or ridges remain tolerably flat; and if it be subsequently ploughed across and circularly harrowed, no sensible elevation or depression will remain to destroy the equality of the surface. If, however, we would bestow the best possible tillage on a piece of ground, it will be advisable not to leave the ridges always in the same place, but to change their position by uniting the halves of two different ridges. To effect this, the shoulders of the ridge must be turned over into the furrow, and the slices successively raised supported one against the other until, on reaching the middle of each of the whole ridges, furrows are formed in those places formerly occupied by the crowns or summits. In this manner, that portion of ground which had

* In order to render the subsequent remarks more easy of comprehension, I consider it requisite to give exact definitions of certain technical terms used to designate the various operations and other matters connected with ploughing.

To *plough a ridge outwards* is to begin the ploughing in the middle, so that the first two furrow slices cut by the plough may rest one against the other.

To *plough inwards* is precisely the contrary; it consists in beginning at the two sides, so that the slices first divided fall into the trenches by which the ridge is bounded, and the last two falling in opposite directions leave an open space or furrow in the place previously occupied by the crown or summit of the ridge.

A *ridge* or *bank* is a band of earth formed by the junction of two or more plough-lines, and terminated on each side by a trench.

A *hollow* or *gutter* is a single furrow traced by the plough.

The crown of the ridge is its highest part, where two divided slices of earth cut from the furrows have been thrown one against the other.

The shoulder of the ridge is that part of it which abuts on or terminates it towards the trench.

The trench is the hollow space from which the plough has removed that portion of earth which forms the shoulder of the ridge; or, in other words, it is the hollow ridge which one ridge forms with another, and serves to drain off the superfluous water.

The furrow is the long hollow space which the plough forms as it separates and turns over the slice, or that space which was occupied by the slice before it was detached and removed.

The furrow-slice or *sod* is that portion of earth which the plough raises from the furrow, and turns over on the side.—French Trans.

been merely covered by the two first furrow slices forming the crown, becomes perfectly tilled and cultivated.

The flat mode of ploughing is decidedly preferable in places where portions of land of considerable breadth belong to the same proprietor, and where there are no particular and important reasons for giving the preference to high and narrow ridges. In most cases these advantages outweigh those which are incontestibly attached to the latter description of ridges. The drainage of water, the accomplishment of which is in many places sought to be obtained by means of the furrows which separate the ridges, is always effected much more completely by means of the furrows which are traced on land ploughed evenly, and immediately after the seed has been sown; and the more so as these furrows are always traced in the direction most likely to facilitate the drainage of the water, and have an advantage not always possessed by the furrows which separate the ridges from one another. Great numbers of these channels or drainage furrows may be made in places where they are necessary, and they may be altogether let alone where not required. On land which is ploughed flat and evenly, the vegetable mould remains equally distributed over the whole surface; whereas, that which is ploughed in ridges is deprived of it in some places and overloaded with it in others. The former retain over their whole surface an equal thickness of newly turned earth; they also admit of a more equable distribution of the manure, which, on lands ploughed in narrow ridges is apt to collect in the furrows. Then, again, the soluble extractive matter of land ploughed flat is not carried away as it is down the slope of the ridges into the furrows. But, above all, the seed can be distributed much better and more equally over evenly ploughed land; it may, in fact, almost be scattered at random: the harrow also acts more uniformly over the whole surface than it can do over the surface of land ploughed in ridges. Circular harrowing, which is so exceedingly efficacious, is almost impracticable on land ploughed in ridges; and even cross harrowings is rendered much more difficult by this mode of arranging the surface. Moreover, land ploughed flat is much more easily cleared from couch-grass, and all those weeds which multiply by means of their roots; the carriage of the manure and especially of the harvest is facilitated there; and lastly, the reaper, binder, and gleaner, accomplish their work on it with much less difficulty. The corn lies flat upon it after having been separated from the stubble, and does not fall into the furrows and get spoiled by the water lodged there, as is too frequently the case on land which is ploughed in narrow ridges. The rake also performs its office with much more ease and promptitude; in fact, it is only on land ploughed in this manner that it is possible to use the large rake, an implement of great utility at harvest time.

The advantages just enumerated are so great, that it is only a small number of particular cases, of which we shall presently have to speak, that can warrant the formation of ridges on a flat soil.

The equal distribution of all the elements of fertility over land ploughed evenly gives an equal degree of strength and a uniformity of appearance to the whole crop. On such land we do not see the disagreeable spectacle presented by elevated ridges, on the top of which the corn is too rich and is laid; while the sides and the hollows present nothing but impoverished, sickly looking plants, or, what is still worse, weeds.

The ridges usually formed on land may be divided into three classes:—

1. Ridges or banks of the width of 16, 20, or 30 plough-lines or more.

2. Narrower and less elevated ridges, which are not bounded by deep furrows; these are from 6 to 8 or 12 plough-lines in width.

3. Narrow and considerably elevated ridges, separated from each other by deep furrows; these are from 4 to 6 or 8 furrow-slices broad.

It is necessary to distinguish properly between these different kinds of ridges, in order that what we are about to say with regard to them may be properly understood. Ridges of intermediate widths may doubtless be found, the classification of which is, therefore, uncertain; but such are chiefly found only in those places where tillage is ill-conducted, or directed by those persons who act without method or reflection.

Broad ridges, elevated in the centre, are often formed by accident and without intention, especially where the property has been divided into long narrow strips of land. For since land so divided must have been twice ploughed from the middle outwards for every time that it was ploughed from the edges inwards, the earth must necessarily have become heaped up in the middle, and the crown of the ridge thus formed. In places where, as is frequently the case, there have been no ditches between the lands of different proprietors, or where these ditches have been filled up for the sake of gaining additional surface, all the ploughmen have avoided throwing the earth to the outside, from fear that if they did so their neighbour might carry off that which was thus placed within his reach. In this manner, ridges of considerable breadths have become elevated in the middle to such a degree, that two men walking in the parallel furrows which bound them will not be able to see each other.

Such ridges or banks are not only found on lands in which there is more to be feared from wet than from drought, but even on dry and sandy soils. It is usually advisable to form moist lands into broad ridges, as it is said that by this means a portion at least of the crop is secured, and good produce obtained from the crown of the ridge, even if that on the side is sickly, or small in quantity. It is thought also, that if the ridges were less elevated, the crop obtained would be next to nothing. It is true that in the greater number of cases this inconvenience might be obviated in another way, and that here the preference should be given to high and narrow ridges. Nevertheless, the use of high and broad ridges is attended with advantages quite peculiar to itself, and if the arc formed by their segment be properly rounded, and the furrows which bound them made of a proper depth, they afford the best and probably the only means of turning to account lands which are parcelled out into small portions and intermingled with the property of others.

It must, however, be observed, that ridges of this description are frequently met with on dry lands, and in districts where there is little humidity; in such situations, so far from being attended with any advantage, they are calculated to do nothing but mischief in every way. These broad and highly curved ridges are often formed gradually and quite unintentionally, by ploughing them from the middle to the edges more frequently than in an opposite direction; in other cases, they owe their formation to an ill-advised imitation. I know, indeed, an instance of a person, who, attributing the heavy crop yielded by a stiff soil thus divided to this method of ploughing, thought he should obtain a similar result from a sandy soil in the neighbourhood by treating it in a similar manner.

The following are some of the principal inconveniences resulting from broad and very elevated ridges.

1. The best mould, that which has been most completely manured, becomes heaped up in the middle of the ridge, and gradually removed from the sphere of usefulness and activity by the depth at which it is immersed, while the virgin or barren earth is continually being taken from the bottom of the furrows and carried to the sides of the ridge.

2. Although the crown of the ridge is preserved from superfluous moisture, the sides are much more exposed to it. Besides, the water is often enclosed in the trenches, on account of the end ridges or borders being equally as high as the others, and thus preventing that drainage which would otherwise take place there.

3. During long-continued rains the water often overflows as high as the crowns of the ridges, even when there is a free passage for its escape; because, in proportion as the light soil has been heaped up on the crown of

the ridge, just in a similar proportion has a quantity of plastic clay been raised from the bottom of the trench and deposited on the sides. Now, this clay completely prevents the water collected in the porous soil of the crown of the ridge from draining away. This water can neither make its way into the impervious soil of the lower stratum, nor pass out through the clay on the sides of the ridges. Such are some of the most evident disadvantages of broad elevated ridges in wet weather.

4. On the other hand, in dry weather, when light showers are so beneficial to the crops, those banks or ridges which are very high, and the sides of which slope abruptly, derive but little advantage from this source, because the water, instead of penetrating the hardened crust which covers the surface of the soil, merely glides over it and flows off into the furrows; and thus it not unfrequently happens, that after such a shower the quantity of water which flows into the furrows is more than sufficient to fill them, while the crown of the ridge remains almost as dry as it was before.

5. Broad, high ridges prevent the sun from exerting an equal influence over all parts of the surface. This is particularly the case when the ridges run from west to east; for there is then a striking difference between those sides of them which have a northern, and those which have a southern aspect. On the northern side the crops are much less luxuriant, and their growth is, likewise, much retarded. The difference in the progress of vegetation on the two sides is sometimes so great that it becomes necessary to reap the corn on the southern side long before that growing on the northern side has reached maturity.

6. When, during the rigour of winter, the snow which covered the crown of the ridges has been blown away by the wind; or when, in the most critical part of the spring season, the sun melts this snow during the day, and the water in the furrows overflows the ridges and freezes there during the night, the plants on the crown of the ridge are often torn up by the roots and completely

destroyed; so that the portion of land from which most was expected, yields no crop whatever.

7. If, on the other hand, the temperature is favourable to vegetation, the corn on the crown of the ridges sometimes becomes so luxuriant that it is laid, and yields but a small quantity of grain; while on the sides of the very same ridges, and especially near the furrows, the plants have a most wretched appearance, and yield but very poor ears from a different cause.

8. The difficulties attendant on the operation of ploughing are greatly augmented by these ridges. It is hard to say which is the best period to select for its execution. The crown of the ridge is often quite hard from drought, while the sides, and still more the shoulders, are so soft as scarcely to be able to support the pressure produced by the feet of the cattle. In such cases, a judicious husbandman will plough the crown of the ridges first, and defer the ploughing of the lower part until the soil there shall be sufficiently dry. But it is easy to conceive how much the sowings must be retarded by such a mode of procedure, and how greatly all the difficulties of ploughing must be increased.

9. Circular harrowing is absolutely impracticable on these ridges; the advantages resulting from this operation are, therefore, lost to land laid out in this way. It is, likewise, very difficult to spread the seed over them in an equal and uniform manner; and the labour of this operation is rendered much greater, as also is that of the harvest.

10. The apparent advantages accruing from the increase of surface obtained by laying out land in these undulating ridges, are more than counterbalanced by the deficiency of produce on a large portion of the surface.

These disadvantages are so palpable that the least reflection would long ago have been sufficient to cause the abandonment of the practice of ploughing land in broad high ridges, at all events wherever the width of the land would admit of its being abolished, had not even the most enlightened agriculturists been deterred by the fear of the losses resulting from the use of ridges of a medium size, when the change is effected too suddenly.

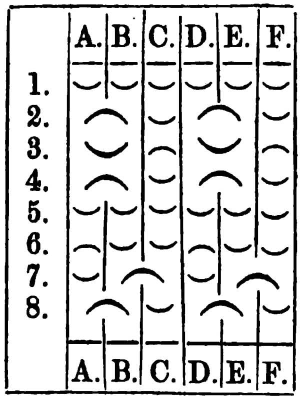
Where these broad and elevated ridges have been only recently formed, the alteration and reduction of them may be commenced without delay. I have known several instances in which this alteration has not only been effected without the slightest loss, but has, on the contrary, immediately led to the production of much finer crops. But when these ridges have existed for a considerable period, and the soil, which is naturally fertile and was heaped on the crown of the ridges, has been for a long time withdrawn from the action of the atmosphere, and pressed down by the feet of the cattle to the bottom of the furrow traced by the plough, then, I say, this soil, although it may contain a sufficient proportion of humus and carbon, is unfit for vegetation, and requires to be gradually called into action by the atmospheric air.

If too great a quantity of this earth be brought to the surface at once, the air does not appear to contain a sufficiency of matters to saturate it thoroughly and restore it to its natural fertility. The vegetable mould which has been thrown to the bottom of the furrows, is equally liable to be buried at too great a depth; at all events, it does not compensate for the loss experienced at that part of the land formerly occupied by the crown of the ridge.

The ridges ought not, therefore, to be lowered all at once, nor the land turned up and tilled to too great a depth at first; especially if these operations are not to be followed by a complete dead fallow.

A very skilful agriculturist has pointed out the mode of proceeding in the triennial crop-rotation, accompanied by fallows, in order to reduce these broad and elevated ridges in the course of three years. The method which he has adopted with complete success is fully described in "The Annals of the Agriculture of Lower Saxony." Third year.

The following figure will assist us in explaining it :—



The mark ⌒ signifies ploughing *outwards*, while ⌣ signifies ploughing *inwards*.

For the Fallow Year.

1. *First ploughing*. Plough all the ridges inwards.

2. *Second ploughing*. Plough the ridges A B together, outwards; that is to say, begin the operation by throwing the two first furrow slices into the furrow which separates them, and leave off at their two outer trenches. The ridges D and E, are to be similarly treated; C and F are to be again ploughed inwards, so that they may fill the furrows which separate them from A and B, and D E; the trench in the middle of C and F remains.

3. *Third ploughing*. This is begun at C and F, which are ploughed outwards; on the other hand, the large ridges, A B and D E, are ploughed inwards.

4. *Fourth ploughing*. C and F are ploughed inwards, while A B and D E are ploughed outwards and united. Before the grain is sown, the trenches in the middle of C and F are filled up by two light ploughings. After the seed has been spread over the ground, the furrows necessary for drainage are made.

For the Spring Corn Year.

5. *First ploughing*. All the ridges are ploughed inwards. This operation must be very superficially performed.

6. *Second ploughing.* A and D are ploughed outwards in the spring; B, C, and E, F, ploughed inwards.

7. *Third ploughing,* and that which precedes the sowing; B C and E F are united, while A and D are ploughed inwards.

For the Third Year. Peas.

8. A is united to B, and C and F are ploughed inwards.

By means of cross and circular harrowing, the soil will by this time be so completely levelled as to admit of its being ploughed across after the crops of peas have been gathered. The last traces of the old ridges will thus be obliterated, and the vegetable soil so well mixed that there will be no reason for apprehending any failure of the crops sown there either during the operation or subsequently to it. Sometimes, after the first ploughings, the soil accumulated in the places previously occupied by the furrows, becomes pressed down, and forms hollows here and there; it is, therefore, necessary to pay great attention to the formation of the drainage furrows, so that the stagnation of water may, in all cases, be prevented. If the hollows just spoken of be of considerable dimensions, it will not be difficult to fill them up by throwing earth into them with the plough.

Should the spots formerly occupied by the crowns of the ridges appear to be too much impoverished, a little manure may be put upon them.

This plan of operations may be modified according to the position of the fields.

Narrow and *slightly raised ridges* are adopted in several countries. As these ridges are only raised in a trifling degree above the furrows, they are not liable to the same objections as those which are much raised; but the number of furrows is increased far beyond what is necessary. Although these trenches are sown as well as the other portions of the land, yet they yield but a very light crop, either because they are less rich in vegetable mould, or because the water which collects in them during wet weather is very injurious and prejudicial to the growth of corn. It is true that the crowns of the ridges yield a heavy crop from the circumstance of the vegetable mould and manure being heaped there; but this does not compensate for the loss on the other parts.

Sometimes the position of the ridges is never changed, but they are ploughed alternately inwards and outwards. As it is in this case difficult to make the plough act upon that slice which remains in the centre and forms the crown of the ridge, that point is often wholly neglected.

In other places, a far better plan of proceeding is adopted, namely, that of altering the arrangement of the ridges so that their crowns may come into the places formerly occupied by the furrows, and these latter be situated where the crowns of the ridges formerly were. Recourse is also had to cross ploughing, and then the ridges are not formed until that ploughing which immediately precedes the sowings.

Ridges of this description present only two advantages: first, the thickness of the vegetable mould on the space occupied by the ridges is slightly increased; and secondly, the circulation of air between the plants, to which this arrangement of the surface gives rise, tends to diminish that inclination which corn has to droop or be laid when it grows on too rich a soil.

It is very necessary to distinguish between the kind of ridges just spoken of and those which are *narrow*, and at the same time *highly elevated and curved;* such as in some districts are formed by the union of four, six, and sometimes eight plough-lines, and are occasionally so much elevated as to rise to the height of fifteen and often eighteen inches above the furrows. Ridges of this description are to be met with in Franconia, and some countries south of Germany; in various departments of the south of France; sometimes also in Spain and England; but most of all in Belgium. We find a detailed account of those used in this latter country in Schwertz's work, entitled, "An Introduction to the Knowledge of Belgian Agriculture."*

* Anleitung zur Kenntniss der Belgischen Landwirthschaft.

Opinions are so much divided respecting the utility or inconveniences of this kind of ridges, and the propriety of retaining or rejecting them, that we deem it necessary to give a detailed account of the arguments advanced on both sides; for, however absurd they may appear, they are nevertheless supported by the authority of agriculturists of the highest talent, and by the practice of many eminent men.

In the first place, the advantage derived from these ridges by vegetation is, that the plants are supplied with a thicker layer of earth, which is composed entirely of vegetable matter, light, and strongly impregnated with substances derived from the atmosphere; this layer is collected afresh at each ploughing, and, consequently, the plants can easily penetrate it with their roots, both in a vertical and horizontal direction, and derive the requisite amount of nourishment from it. On soils thus arranged, when the ridges are well formed and the furrows traced in such a manner as to enable them to discharge all the water that runs into them, the plants never suffer from excess of moisture, and are equally safe from those injuries resulting from excessive heat; because the light earth heaped up by the plough is capable of retaining moisture for a considerable period. In places where the lower stratum of the soil is impervious, the plants are raised up sufficiently high to remove all fear of their being injured by stagnation of water; so that even in those parts of the field where the furrows are filled with water, for want of proper outlets for drainage, the ridges are often seen covered with very fine healthy crops. It is said to be a very rare occurrence for plants growing on this kind of ridges to be injured by the winter. The atmosphere exerts its beneficial action upon the soil of such ridges, and especially on their elevated shoulders during the whole period of vegetation; these shoulders are exposed to the fertilizing influence of the sun's rays, and the plants growing on them enjoy all the advantages of light and heat.

Again, as this arrangement of the surface supplies the plants both with light and air, it favours the formation and ripening of the grain in the ear, causes a more prompt evaporation of the water with which the plants are charged during wet weather, and consequently lessens the danger of their being laid; it allows of the crops being hoed, and therefore enables us to keep the soil free from weeds. Finally, it cannot be denied that in Belgium, land arranged in this manner always yields very plentiful crops.

Other persons advance serious objections against high, narrow ridges, and affirm that the following inconveniences have resulted from their adoption of them:—

They occasion the loss of a considerable extent of surface, for the furrows yield no produce; thus, one-half, or at least one-third, of the land is barren, or, at all events, yields but a scanty crop.

It is difficult to form these ridges; it takes a great deal of time and a great deal of draught power to plough them outwards.

It is no less difficult to plough them inwards, or to unmake them; and this operation is often very imperfectly performed. It is not unusual for the last strip of earth to remain unploughed, because the plough has no hold on it, and falls into the furrow.

The sowing of these ridges is likewise difficult; the seed does not get equally distributed, and thus a great deal of it is lost. But the operation which is most imperfectly performed is the harrowing.

If high ridges enjoy the fertilizing advantages arising from the action of the atmosphere, they are likewise more exposed to its influence at periods when that influence is prejudicial to vegetation. Injurious variations of temperature have more effect upon land heaped up in this manner than they have upon a flat surface.

The produce of the crops obtained from high narrow ridges is, even under the most favourable circumstances, not greater than it would be if the same land were cultivated with care, but on a less troublesome and expensive plan.

The ridges in question render the gathering in of the harvest a much more difficult operation.

The question respecting the advantages and disadvantages of these ridges having been lately revived, I think it requisite to state my own opinion on the subject with some degree of precision; acknowledging, at the same time, that I have not hitherto had any opportunity of observing the effects of this arrangement of land, or of making trial of it, and, consequently, do not speak from personal experience.

There is no reason to fear that, by the adoption of these ridges, any part of the vegetable soil will be rendered inactive, especially in places where the stratum of it is not sufficiently thick, since the earth when thus heaped up is no less within the reach of the plants, the roots and suckers of which penetrate sufficiently deep into the loosened earth to enable them to reach all parts of it, and thence to derive a requisite supply of nourishment. In fact, plants are enabled to grow more closely together on these ridges, on account of their roots being able to penetrate deeply into the ground, and having less occasion therefore to spread themselves horizontally; consequently, they do not injure those which grow next to them. Above ground, the ears which would otherwise have been too close together have more room to expand. Many persons who have seen land cultivated in this manner assert that there are no empty spaces to be seen between the ears of corn which grow upon it. When the layer of vegetable earth is too thin to admit of the plants penetrating to a sufficient depth, this defect is sensibly diminished by the heaping up of the earth upon the ridges, and, consequently, the plants growing on it acquire greater strength and firmness.

On the other hand, it cannot be denied that, when land is arranged in this manner, the operation of ploughing becomes more difficult, and takes up more time. The formation of the ridges on a flat surface; the labour required for changing their position; that of lowering and cutting down the crowns of the old ridges; cartage; the spreading of manure, and particularly the manner of applying it to the surface of the soil, covered merely by the earth which has been taken from the furrow, and to the shoulders of the ridges; the digging up and deepening of the furrows with the spade; the clearing and weeding the ground; the breaking up of the superficial crust; the operation of double ploughing, which consists in driving two ploughs one after the other along the same furrow; the use of the levelling machine; the raking up of weeds; and all those manifold operations described in detail by Schwertz, require great labour, care, and practice: so that, as the author himself observes, the proper execution of all those manipulations is the practical test of the skill and industry of the husbandman. It must be always borne in mind, that these ridges cannot fulfil all the purposes for which they are intended unless every requisite operation is properly and carefully performed; where such is not the case, a very indifferent crop is sure to be the result.

It is for this reason that in places where the agricultural labourers are not very skilful that the crops are nowhere so poor and bad as they are upon land thus arranged; whereas, upon the land of the industrious Belgian, the finest crops are always those grown on ridges. Hence it would appear that this arrangement of the surface ought not to be practised, or even recommended, excepting in places where the hand of the proprietor himself, or, at all events, his vigilant eye, superintends every operation; and where, as in Belgium, the labourer has an immediate interest in the success of the crop. It is very evident that this practice is not equally well adapted for large farms in which it is impossible for the proprietor to exercise a strict surveillance over the whole, or for places where proper care and attention in the performance of all the operations of husbandry can only be obtained by the employment of coercive measures, and does not arise from a zeal and an interest in the work itself.

As to the manner of sowing and harrowing these ridges

I confess I am unable to form a distinct idea of it. It seems to me that an immense quantity of seed must be wasted, unless indeed very great pains are taken in the spreading of it. I do not understand how the harrow can penetrate the ground to a sufficient depth to distribute the seed properly and break the clods, without at the same time lowering the ridges and filling up the furrows; I have looked in vain for any explanation of these difficulties in Schwertz's work.* Probably the soil

* Generally speaking, the use of narrow ridges has only obtained a footing in those places where the soil is light, and where the ploughings are merely superficial. In such situations they make use of a harrow adapted to the form and size of the ridge, or use two harrows of the same kind, which cover two ridges, and are fastened together in such a manner as to act simultaneously without interfering with or impeding one another. I have seen such on the fertile plains of Lodi. In working these harrows the driver walks behind, holding in one hand a whip or a long stick armed with a goad, and in the other a kind of handle attached to the harrow with a small chain, and which enables him without difficulty or inconvenience to direct that lateral motion of the instrument that shaking produced by the roughness of the ground, which contributes so efficaciously to the breaking of the clods.

In the vicinity of Parma and Modena the lands destined for the production of autumnal corn are all divided into very narrow ridges; notwithstanding that they are of an argillaceous nature: but, instead of the harrow, a kind of levelling machine is there made use of, composed of two cross pieces, and which acts upon two ridges at a time. If the land be covered with large clods, care is previously taken to divide them with mallets. The seed is generally sown in rows, but there would be no sensible disadvantage in sowing it at random, since in clearing out the trenches that portion of seed which had fallen between the ridges might be taken up.

In Bologna and Romagna, where a considerable portion of the land is of a highly argillaceous nature, the fields are divided into elevations of from thirty to forty inches in breadth, slightly curved, and bounded by ditches or drainage furrows, and even the autumnal corn is sown upon them in lines. After having levelled the ground as evenly as possible, the seed is scattered over it at random, and then buried by making small ridges, or rather undulations, about one metre in breadth, but which are not separated from each other by absolute furrows. In order to form these undulations, the ploughman sometimes uses the ordinary plough, and then finishes the ridge in two plough courses; but he more frequently makes use of a plough with two mould-boards, which, by throwing the earth raised by the share both to the right and to the left, forms in one single course the halves of two ridges, which are afterwards completed in the same manner. In order to bury the seed more completely and level the surface a little, a beam of wood, to which is attached a number of furze bushes or boughs of trees, is dragged over several of these little ridges at once. This operation breaks the principal clods, and throws back a small quantity of mould and seed into the hollow which separates the ridges. But when the soil is very tenacious, this operation does not prevent hollows or small heaps of earth from remaining between the ridges, which retain the water during winter and injure all the plants in their neighbourhood. Besides, as the beasts of draught always walk over the place which is to be occupied by the crown of the ridge which they are forming, they bury a portion of the seed with their feet to a very great depth. It is true that this seed is replaced by that which the plough throws on to these places, together with the sod or furrow slice; but, is so well prepared by the preceding operations, that it divides and breaks up of itself.

One of the principal advantages attendant on narrow ridges arises from the facility with which in so populous a country as Belgium they admit of the crops being weeded and cultivated; but in those places where it is altogether impossible to devote the requisite time to the weeding of the crops, the weeds increase rapidly on the shoulders of the ridges, and the crops are not so neat and clean as they ought to be. These narrow ridges are peculiarly adapted for the practice of sowing corn in rows, so strongly recommended by Tull; that great agriculturist having directed that the seed should be sown in two or three rows on the crown of the ridge, by means of his sowing machine; while the shoulders are alternately ploughed inwards and outwards, and submitted to the fertilizing influence of the atmosphere.

In order to free the soil from its superabundant moisture, it is only necessary to make a large number of the furrows which separate the ridges; this object can, however, be much better attained by means of furrows, made in the direction best calculated to carry off the water. Where the land is too flat to admit of this mode of drainage, raised ridges certainly are useful: but even then their utility is but very imperfect, and only capable of protecting the crops against a very moderate degree of humidity.

I shall not venture to decide whether or not the top of the ridge which is first divested of its covering of snow, does or does not suffer more than an even uniform surface during the spring, when the ground is alternately frozen and thawed, and during the very cold nights which occur about that time. It appears to me that such must be the case; since in those springs which have presented

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then, the bottom of the ridge is so much the more deprived of it. These disadvantages will be apparent to any one who will cast an attentive glance over the corn crops of these two countries. I, therefore, endeavour to persuade my farmers, both of Bologna and Romagna, to substitute ridges of the breadth of five metres for these undulations, and to separate them by furrows properly cleared.—FRENCH TRANS., 1814.

the greatest variations of temperature, such for example as that of 1804, the tops or crests of the wide ridges which in general yielded the finest crops were so much injured by the severity of the winter as to yield no crop at all.

In my opinion, it is an incontrovertible fact, that the getting in of the harvest cannot be so easily effected, and requires more hands on land laid out in ridges, than it does on flat fields: the common scythe—that instrument which tend so materially to facilitate the labour, cannot be used here—nor can the large rake: the sickle is chiefly employed in places where the soil is thus laid out, and the corn is placed in bundles, which, on these raised ridges, requires great care, and cannot be done without the aid of a great number of labourers.

With regard to the formation of these ridges, and all the operations thereunto appertaining, I must refer my readers to the classic work of Schwertz, of which I have already spoken, a work which every person who intends to introduce such a system of cultivation on his land ought to be in possession of. I am the more induced to make this reference from the circumstance of not knowing the exact way in which such ridges are formed.

The first consideration to be taken into account when land has to be thus laid out in ridges, is the direction of the inclination most likely to facilitate the drainage of moisture from the furrow, and such a one should be adopted unless there are good reasons for preferring some other. But where this point is quite immaterial, the ridges should be traced from north to south, in order that the grain on each side of them may enjoy nearly equal advantages from the influence of the sun's rays; otherwise, the vegetation of those parts inclining towards the north, will be much more backward than that on those which face the south. Were it not for this, it would be better to plough from east to west, because the soil then receives the rays of the sun more vertically so long as it remains in the state in which it was left by the plough, and profits more by their influence.

On fields situated on mountains, hills, or declivities of any kind, the ridges are usually arranged in a very injudicious manner, viz., in the same direction with the declivity of the soil. Such is, at all events, the case in places where the land is very much divided and the property intermingled, probably because, from the time the division was first made, nobody has been found who would take the superior or upper part for his portion, all the fertilizing juices and particles of which are washed downwards, or would resign his share of the lower parts which possess so many decided advantages.

This injudicious arrangement of the ridges is attended with many inconveniences. When heavy rains fall, the vegetable soil is easily washed away by them; and it not unfrequently happens, that at the top of the declivity large hollows are to be found, from which the earth has been washed down to the bottom, where it forms high embankments. When only light showers fall, the water runs too rapidly from the upper part of the field, which is often suffering from drought, while the lower portions have a plentiful supply of moisture. The cattle employed in ploughing are dreadfully exhausted by the up-hill work; those which are naturally indolent and disinclined to exertion, require very severe treatment to make them get through their work; while others, that are active and full of spirit, become heated, and are thus rendered liable to take disease. Nothing, therefore, but a minute parcelling out of the land can justify such an arrangement of the ridges.

The most advantageous disposition of them that can be made on an inclined surface, is to give them a horizontal, or slanting direction. The former is perferable on gentle declivities; the latter on abrupt inclinations. By this means moisture is retained longer in the trenches on heights exposed to drought, and more humidity is communicated to the superior ridges. Even on rapid declivities, the water flows slowly in those furrows, the obliquity of which diminishes their inclination. When heavy rains fall, they do not wash the earth from the bottom of the furrows; and if the showers come but seldom, the land does not suffer so much from dryness. It has sometimes happened that the mere act of changing the direction of the ridges has tended considerably towards the amelioration of property situated on hilly places, increased the amount of produce obtained from it, and rendered the crops less casual.

The arrangement just mentioned is also calculated to lessen the labour of the draught cattle, although it cannot be denied that it increases that of the labourer. When fields situated on a declivity are ploughed by a common plough, having an immoveable ear which turns the slice alternately upwards and downwards, it is very difficult to produce a proper reversion of the furrow slice when turned from the lower side, because, in that case, it has to describe a larger segment of a circle before it arrives at that point from which its own weight will cause it to fall over. It not unfrequently happens that it falls back into the furrow. The ploughman is, therefore, compelled to exert all his strength to keep the plough inclined towards the right, and is frequently obliged to turn over the slice with his foot, unless he is followed by some person whose express duty it is to turn over the slice with his foot, his hand, or with a fork. The best thing which can be made use of in such cases, is that elongation of the mould-board described by Schwertz in his "Agriculture of Belgium."

On rapid declivities it is almost impossible to turn the slice over from below upwards. There the only thing to be done is always to turn the slice towards the bottom, until the whole field is transformed into a series of terraces, each one lower than the other. This cannot be effected with a common plough, having an immoveable mould-board, except by managing it so that it shall always be engaged in the soil on one side, and shall turn the slice over on the one that immediately preceded it, a mode of proceeding which occupies a great deal of time, and fatigues the cattle very unnecessarily, causing them to pass over every inch of ground twice. It is far better to make use of a plough having a moveable mould-board, which can be turned either to the right or left, as seems requisite.

Instruments of the description just mentioned are invariably used in all places where they are known. The Mecklenburg binoir is very useful in these circumstances; indeed, in many cases it is superior to the plough, because it does not throw the earth so low as that instrument. It will easily be conceived that by degrees the plough will amass all the good soil at the foot of the declivity, while the top will become barren. Judicious agriculturists remedy this evil by applying all their manure to the upper part of the field, or, at any rate, distributing it in such a manner that that part shall always receive the greatest proportion; but this renders the carriage of the manure a much more laborious operation.

When rapid declivities are ploughed in a slanting or inclined direction, it is of the utmost importance that such an inclination should be given to the ridges as will prevent the plough from having to encounter any sudden or abrupt declivities. Nothing but mere general rules can be laid down for guidance on this point. The first thing a farmer should do before laying out the ridges, is to traverse his land in all directions, and ask himself in different places how the slices can best be turned over. In some places he will find it necessary to plough outwards; in others, to plough inwards; and in others, again, always to turn the slice over on the same side. The facility with which the work will be performed, as well as the goodness of it, will depend essentially upon the accuracy of the ploughman's eye, and his skill and experience in operations of this nature. The binoir will, in general, be found to be preferable to the plough on hilly fields, because in turning over the soil it enables the labourer to exercise his will and judgment with greater freedom. It is a beautiful sight to see the order and regularity with which rapid declivities can be ploughed by skilful men, who are accustomed to the use of this instrument.

By means of the arrangement of which we have been speaking, and by giving an oblique direction to the furrows, the water may be made to drain away so gradually as not to carry any portion of earth with it, nor yet deepen the furrows through which it passes.

If it should now be asked, what depth should be given to the ploughing, the variety of opinions which exist with regard to this point entangle us in a labyrinth of discussion, through which we vainly endeavour to thread our way. There is a very great difference between ploughing a soil deeply, the vegetable layer of which is not only homogeneous to a considerable depth, but is also equally fertile throughout the whole of that depth, and augmenting a more or less superficial layer of earth by means of deeper ploughings; or, in other words, rendering its constituent parts homogeneous to a greater thickness, and impregnating them with fertilizing particles throughout their whole extent.

Every attentive observer must admit the manifest superiority of deep over shallow soils. The depth to which the roots of plants will penetrate when they meet with a fertile soil, varies according to the nature of these plants. There are some, the roots of which have been traced to a depth of fifteen, twenty, and even thirty feet; as, for example, sainfoin and lucerne. Red clover will push its roots to a depth of nearly three feet; and several other plants of common growth probably penetrate even to a greater depth, when, instead of encountering obstacles, they meet with a loose, fertile soil. I have pulled carrots two feet and a-half in length, the tap root of which was probably another foot long. But as land is chiefly devoted to the cultivation of various kinds of grain, its value ceases to increase beyond the depth attained by the roots of cereals; at least to a similar extent.

The unassisted eye will frequently enable us to trace the roots of corn to a depth of eight inches; and, with the aid of a magnifying glass, we can distinctly see that these roots have been broken off, and some portion of them still left in the ground. I have myself seen corn grown on the shoulders of ridges, with roots twelve inches long; but I do not think they would have attained this length anywhere excepting on the shoulders of the ridges, where the influence of the atmosphere is sufficiently powerful to encourage their growth: they would never have penetrated so far on a flat soil, even had it been equally rich. The seed, when sown, is usually placed about two inches below the surface of the soil; consequently, the roots which we can see are six inches long, and it is more than probable that the fine extremities of their fibres extend to a depth of at least twelve inches. Hence it appears that we may consider twelve inches to be the proper average depth for a soil adapted to corn, and admit it as a principle, that the plants penetrate thus far, where they find the earth sufficiently loose and friable. Where the plants are sown very closely to each other, their roots are still more disposed to penetrate into the ground. Wherever we have the opportunity of observing, we shall see that the roots avoid each other, and put forth their largest shoots in those places where they will not interfere with others: this is most perceptible in plants growing in water, because we have more opportunity of observing the direction of the roots there. When, therefore, a plant is prevented by those around it from extending its roots in a lateral direction, it pushes them downwards, provided that instead of encountering obstacles, it meets with a loose soil well impregnated with nutritive matter. But if, on the contrary, the root encounters a hard or sterile substance, it extends itself on all sides; and, in this case, when the plants are very close together, their roots form a thick and knotty tissue, dispute with each other for room and nutriment, the weakest give way before those which possess more vigour, and, however advanced in their vegetation, are weakened, or latterly perish. The deeper a soil is, the nearer together can plants be made to grow in it, without injuring each other; and the greater number of them will attain to perfection. No attentive observer can avoid remarking the wide difference which exists between deep and shallow soils. It appears in proportionate degrees in soils of four, six, eight, or twelve inches in depth; provided that such soils are equally impregnated with humus throughout their whole extent. If it were possible to conceive that each grain of corn bears a plant, we ought to be able to sow land having a layer of vegetable soil eight inches in thickness twice as closely as we could one which had only four inches depth, and obtain a double crop from it. In this manner the value of the soil would be determined by a multiplication of its surface by its depth.

But we must not, however, venture to carry out this principle to its fullest extent, because the influences of the atmosphere always give to extent of surface an advantage over depth: in fact, if we take a cubic foot of earth, and divide it into a space of two square feet, the latter will always bear a greater number of plants than could possibly grow on the former. No impartial observer who has had any experience in this matter, will, however, venture to dispute the fact that depth of land has a great influence over its value. In order not to exceed the bounds of truth, I shall lay it down as a principle that this value is increased eight per cent. by every additional inch of depth which the soil acquires from six to ten inches, and diminished in equal proportion from six to three inches.

But deep soils have likewise another advantage; they suffer much less from drought and from moisture than those in which the layer of vegetable earth is more shallow. When the weather is wet, and a great deal of rain falls, the water sinks into a loose soil, impregnated with humus as low as the vegetable layer extends. Such a soil absorbs a quantity of moisture proportionate to its depth before it suffers any to return to the surface. This is the reason why garden ground, which is well tilled with spade labour, never suffers from excess of humidity even when the surface of shallower soils would be drenched with moisture; so long as the water does not ebb back to the surface of the soil, it does little or no harm to the plants. Deep lands retain the moisture which they have absorbed for a considerable period, and communicate it to the surface when that becomes parched and dried up. Nor is this advantage confined to the extent to which the roots of the plants reach; I am well convinced of this from having noticed that during a long period of dry weather, a crop of cereals growing on land that had some years before been dug up to a depth of three feet, suffered much less than another which grew on a soil only a foot and a half deep, although both these soils had received exactly the same amount of cultivation and preparation.

Nor is this all: crops of grain growing on deep soils suffer much less from sudden changes of temperature, from drought, or from heat; because their roots, being able to penetrate further, are less subject to the action of these influences than they would be if nearer to the surface. During excessively hot or very dry weather, it is evident that the plants are much fresher in deep than in shallow soils; in fact, they invariably perish in the latter.

Lastly, it has been everywhere remarked that corn growing on deep soils is much less liable to be laid even when very luxuriant in vegetation; this is, doubtless, owing to the greater degree of strength which the depth of the roots gives to the lower part of the stalk, a strength which corn growing on shallow soils never can attain, because then the fresh shoots put forth by plants growing closely together cannot find sufficient nutriment to enable them to attain their full vigour. Nor is it to cereals alone that this depth of soil is beneficial; it is not less favourable to the cultivation of plants the roots of which penetrate deeper into the soil, and seek their nourishment beyond the level occupied by the roots of corn. This is the reason why a deeper soil than is absolutely necessary for the cultivation of cereals is always desirable, although the value added by this increase of depth does not increase so rapidly as in the layer which suffices for the roots of corn.*

* "The chemical effect of pulverizing and breaking up a subsoil is certainly advantageous to the plant in two ways, besides others with which we are very likely at present unacquainted; first, it renders the soil penetrable to a much greater depth by the roots or minute fibres of the plant, and consequently renders more available any decomposing matters or earthy ingredients which that substratum may contain; and, secondly, it renders the soil much more freely permeable by the atmosphere, rendering in consequence a greatly increased supply not only of oxygen gas to the roots of the plants, but also yielding more moisture not only from the soil, but from the atmospheric air; which moisture, let it be remembered by the cultivator, is in all weathers as incessantly absorbing by the soil as it is universally contained in the atmosphere, abounding most

But if we would have a soil attain all these advantages, and permanently possess them, it is requisite that from time to time it should be ploughed to the very bottom of its vegetable layer, turned over, loosened, and every part submitted to the vivifying and beneficial action of the atmosphere. Unless this is done, it will, if merely superficially ploughed, generally lose all those advantages of which we have been speaking; a hard crust or *pan* will be formed immediately beneath the sphere of the plough's action, which cuts off the earth beneath it from all communication with the atmosphere and with the layer of vegetable mould. Experience has convinced me that it is not necessary that this deep ploughing should take place every year, but only that it should be repeated once in every six or seven years, especially if during the interval the depth of the ploughings given to it are varied, for nothing contributes so materially to form the crust of which we have spoken as repeated ploughings

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in the latter in the very periods when it is most needed by the plants, that is in the warmest and driest weather.

"It is, perhaps, needless to prove that the roots of commonly cultivated plants will penetrate, under favourable circumstances, a much greater depth into the soil in search of moisture than they can, from the resistance of the case-hardened subsoil, commonly attain. Thus the roots of the wheat-plant, in loose, deep soils, have been found to descend to a depth of two or three feet, or even more; and it is evident that, if plants are principally sustained in dry weather by the atmospheric aqueous vapour absorbed by the soil, that that supply of water must be necessarily increased, by enabling the atmospheric vapour and gases, as well as the roots of plants, to attain to a greater depth; for the interior of a well pulverized soil, be it remembered, continues steadily to absorb this essential food of vegetables, even when the surface of the earth is drying in the sun.

"And by facilitating the admission of air to the soil another advantage is obtained, that of increasing its temperature. The earths are naturally bad conductors of heat, especially downwards; thus it is well known that at the siege of Gibraltar the red-hot balls employed by the garrison were readily carried from the furnaces to the batteries in wooden barrows, whose bottoms were merely covered with earth. Davy proved the superior rapidity with which a loose, black soil was heated compared with a chalky soil, by placing equal portions of each in the sunshine; the first was heated in an hour from 65° to 88°, while the chalk was only heated to 69° (*Elem. of Agri. Chem.*, p. 178). This trial, however, must not be regarded as absolutely conclusive, since the surface of the black soils naturally increases more rapidly in temperature when exposed to the direct rays of the sun than those of a lighter colour. A free access of air to all soils also adds to their fertility, by promoting the decomposition of the excretory matters of plants, which otherwise would remain for a longer period, to the annoyance of plants of the same species."—*Johnson's Farmer's Encyclopædia.*

of equal depth. It appears that the alternate cultivation of cereals and of plants, the tuberculous roots of which penetrate further than the others, likewise contributes towards the loosening of the inferior layer of the soil, and maintaining its communication with the upper and superior layer.

Land ought, therefore, to be ploughed every seven years to the very bottom of its layer of vegetable soil; and the intervening ploughings may be more or less superficial, and varied in their depth according to the purpose for which they are bestowed.

It is quite another thing to bring the layer of earth which is beneath the vegetable soil to the surface by means of deep ploughings, a layer which, even if it is of a similar nature with the superior stratum, is seldom or never impregnated with the same quantity of humus, and never fertilized by the influences of the atmosphere and the substances contained in it. This unfertile and frequently sterile soil, must, in the first place, be ameliorated, impregnated with humus, and saturated by the atmosphere, before we can hope to derive any crop from it.

We have, however, seen cases in which earth thus brought to the surface has, after remaining some time in the air, become exceedingly fertile without the addition of manure. On submitting this earth to various chemical analyses, we ascertained that it contained carbon; but its fertility was speedily exhausted, and if the soil had not been immediately manured, it would, after having borne one or two crops, have become perfectly sterile, and have required repeated ameliorations in order to convert it into good vegetable earth.

It not unfrequently happens that when a new layer of earth is thus dug up it is productive of very bad effects at first, and is so barren that it can only be sown with those vegetables the top-roots of which seek their nutriment at a great depth below the surface; nor does it acquire fertility until it has been repeatedly manured and exposed for a considerable period to the fertilizing influence of the atmosphere. But this method of improving land which requires so large a quantity of ameliorating substances becomes a very serious undertaking when it has to be extended over any considerable extent of surface; under ordinary circumstances, and unless there are very great facilities for procuring manure from extraneous sources, one field cannot be thus improved without depriving all the others of the portion necessary to maintain their fertility; at any rate, it will be necessary to sacrifice the value of the produce of a great extent of surface, in order to increase that of a small piece of ground. It may be that in many cases the value thus acquired by the soil far exceeds the loss in produce; but very few agriculturists are sufficiently speculative to make such sacrifices.

The practice of deepening the layer of vegetable earth by means of digging or deep ploughings, can only be pursued with advantage where the existing system of cultivation tends to produce a larger quantity of manure than can be employed with any degree of profit for the improvement of the actual vegetable soil.

There are many cases in which an agriculturist must be content with a very superficial layer of vegetable earth, and not for a moment think of increasing its depth by digging or by deep ploughings. Not to take into account those places in which the inferior stratum of the land will not admit of its depth being augmented, it frequently happens—

(a). That by means of the turf or herbage which has taken possession of the surface of the soil, a very thin layer of vegetable earth has been formed, beneath which is an absolutely sterile soil, either of an argillaceous or a sandy nature; and the farmer has only just manure enough to preserve the fertility of this layer of vegetable mould, or perhaps he has not enough, and is obliged to depend on the formation of a new layer of turf for the preservation of its fertility. In such a case, instead of deteriorating from the value of this small quantity of vegetable earth by the addition of a new layer of sterile soil, the

best thing which can be done is to keep it as much together as possible, and maintain its fertility by means of the scanty portion of manure which can be allowed to it and by careful tillage, especially if the formation of another layer of turf may be calculated on; for this latter springs almost entirely from the two first inches of the layer of vegetable earth, and the humus contained in the rest has little or nothing to do with it.

(*b*). If the farmer has been endeavouring to amend his land by means of an addition of marly clay, mould, &c., or by paring and burning (practices which are exceedingly beneficial to superficial soils, although not calculated for deep ones), he must take care not to plough or dig this land too deeply, or to disseminate through too large a space that amelioration which is adapted only to a very thin layer of earth. The depth of the soil should never be augmented unless it has been determined that an extra quantity of these ameliorations shall be bestowed, and then the land should be ploughed or dug up before they are applied. The same rule is applicable to those cases in which an argillaceous and very tenacious soil is to be ameliorated with lime or calcareous marl, the quantity of which is only sufficient for a certain thickness or depth of vegetable earth.

(*c*). If a sandy soil has always been ploughed to the same depth, and a hard crust or *pan* has consequently, gradually become formed below the layer of earth submitted to the action of the plough, this crust cannot be broken without doing mischief. If the superior layer of soil has been plentifully ameliorated by good cultivation, this pan which exists underneath it will prevent the moisture, or those fertilizing substances which become detached from the soil, from escaping lower down; and beneath this crust a bed of pure sand will frequently be found to exist. Cases of this nature may occasionally be found united with those appertaining to the former class, for it not unfrequently happens that after land has been marled a similar crust is formed; and, however desirable it may be that this should exist at a greater depth, it cannot be broken or removed further down without doing harm, and therefore it is better to leave it alone.

(d). Lastly, and in almost every case where it is not absolutely necessary that the layer of vegetable earth should be deepened, and where it is likely to produce loss instead of profit.

In by far the greater number of cases in which it is deemed advisable to deepen the layer of vegetable earth, it is best to do it gradually. By the expression "deepening the layer of vegetable soil," we mean the bringing to the surface such a quantity of virgin earth as can be intimately combined with the vegetable soil, and enter into combination with it. By this means the previously existing vegetable layer is not totally buried or rendered inert, and that absorption of substances from the atmosphere which always takes place in newly turned soil becomes more easily effected.

The following are some of the principal considerations which ought to be carefully weighed, prior to the undertaking of the operation of ploughing deeply, or increasing the thickness of the layer of vegetable earth.

1. What is to be expected from the earth thus extracted from the inferior stratum of the soil, and has never before been submitted to the action of the plough, taking into consideration its nature and composition?

To resolve this question, the earth must be submitted to a chemical analysis, in order to discover what proportions of clay, sand, lime, or carbon, enter into its composition; nor must the stones, both small and large, which it contains be left unnoticed. The best way of practically ascertaining the effect which it is likely to produce on vegetation, is, most undoubtedly, to give it a trial in flower pots, or on a bed in a garden which is ploughed up, and then covered with a layer of this earth.

2. What changes will be produced by the admixture of a certain quantity of this earth with the superior layer of the soil?

Will the defects of the latter be increased, diminished, or corrected by such a mixture? Will this new earth give a greater degree of consistence to a loose soil, or will it diminish the tenacity of a clayey one; or, again, will it increase the defects of both or either? What are the proper proportions in which it should be mingled with the vegetable layer, in order to form a soil adapted to the situation of the field and the climate in which it is placed?

3. How far will the quantity of manure which the agriculturist has at his disposal contribute to impregnate and fertilize this new earth to the requisite depth?

Upon these considerations will depend the propriety of performing this operation, and the extent to which it should be carried.

It has not yet been distinctly specified what is to be understood by the terms "deep ploughings," "superficial ploughings," or "ploughings of a moderate depth." In order, therefore, to be able to attach some definite meaning to them, we will suppose a superficial ploughing to be only from two to four inches in depth; a moderate ploughing, one in which the instrument penetrates from four to seven inches; and a deep ploughing, one in which the soil is turned up to from eight to twelve inches below the surface. All ploughings deeper than this, are designated double or extra ploughings; because it is scarcely practicable to turn up land which has not previously been tilled, beyond the depth of twelve inches with a common plough. I cannot form the least idea of those ploughings which are said to be carried to a depth of from eighteen to four-and-twenty inches.

After what has already been said, it will be evident that in the greater number of cases in which it is desirable to plough the land to a greater depth than has before been attempted, it is best not to add above two inches in depth of virgin earth at a time to the vegetable soil; more than this quantity cannot be properly ameliorated and amalgamated with the upper layer. This operation ought, wherever such a course of proceeding is practicable, to be undertaken at that period which will admit of the layer of newly turned earth being exposed to the atmospheric influences for the longest period of time; that is to say, it ought to be performed just before the beginning of winter. It should also be allowed to continue in contact with the atmosphere during the whole summer, because the fertilizing effects of the air are even more effective during this season than they are in the winter. Such a soil ought to receive a dead fallow; or, at any rate, only to be made to bear those vegetables, the top roots of which penetrate beyond the new layer of earth, and seek their nutriment in the old vegetable soil; or else, those plants the roots of which lodge themselves below that layer, as is the case with most of those which come under the denomination of fallow or weeded crops. As the new earth thus remains on the surface of the soil, and is constantly moved and loosened, it enters into close contact with the atmosphere, and every particle of it becomes saturated with atmospheric substances.

It is highly important that the chief and most efficacious portions of the manures should be reserved for this new earth; and wherever the arrangements of the undertaking will admit of it, it is desirable that the manure should be conveyed to it and carefully spread over it before the commencement of winter, and suffered to remain on the surface during the whole of the season, because manure which remains on the surface of the soil during the winter is productive of highly ameliorating effects, provided there are no declivities or slopes down which its juices and succulency may be carried away by the rains. Should such, however, exist, the manure may still be carried to the ground and spread over it at the same time; but then, instead of being left on the surface, it should be carefully buried by a superficial ploughing. In the succeeding spring the ground should again be slightly ploughed and carefully harrowed; the ploughing which precedes the sowing must also be very superficial, in order that the new layer of earth may be as little as possible covered by the old vegetable soil.

In this manner I have repeatedly and successfully effected a complete admixture of a new layer of earth with the old vegetable soil, thoroughly ameliorated the whole, and sensibly increased the depth of the vegetable earth, in the course of one single summer; I have obtained an immediate increase of all the crops, and at the close of the rotation have again proceeded to deepen the soil. Many persons have followed a similar course of proceeding, and have never experienced any of those misfortunes or failures which too frequently attend operations of this nature when performed with too much precipitation, at unsuitable periods, or without due consideration of the concomitant circumstances and of the rotation.

Those who propose to deepen the layer of vegetable earth after the manner described in the previous pages, and to carry this operation to a depth of more than twelve inches, will find a common plough incapable of effecting it. They must, therefore, have recourse to double ploughing, which is performed either by means of the trenching plough, spoken of in a previous page of this volume, or else by two ploughs following each other in the same furrow. In the latter case, the first plough cuts and turns over a more or less thick slice; while the second raises another from beneath the place occupied by the first furrow slice, and reverses it on this latter. This operation can be performed by means of common wheel-ploughs, provided that the second is so arranged as to cause it to penetrate deeper into the soil than the first; and that it has a raised and lengthened mould-board, the hinder extremity of which is divergent, and a high wheel on the right side of the wheel carriage. But the operations performed by means of such a plough are very laborious, and require great draught power. The best way of accomplishing it is to make use of one of Small's ploughs behind, and one of Baily's in front: in this case, three horses will be sufficient to draw the second instrument when the ploughing is intended to penetrate to a depth of from twelve to fourteen inches; but it cannot be denied that the animals will have to work very hard. This operation can be better performed, and in many cases quite as economically, by means of spade labour. Nine or ten men distributed at equal distances from each other may follow the plough; as soon as it has passed, they dig up the ground to the full depth of their spade, and throw the earth which they thus raise on that just turned over by the inplement. Nine or ten good able labourers are quite sufficient to keep pace with a plough on soils of a moderately clayey nature; and where plenty of hands are to be obtained, I much prefer this mode of proceeding.*

Pierre Kretschmar, an author who was very highly

* M. Von Thaer did not live to witness the great, good effects on some sorts of the subsoil plough of Mr. Smith, of Deanston, and of Sir Edmund Stracey, who has given the results of his experience (*Jour. Roy. Eng. Agri. Soc.*, vol. i., p. 256) with a plough he has constructed, and which he calls the "rackheath subsoil-plough."

"On my coming," he remarks, "to reside on my estate at Blackheath, about six years since, I found five hundred acres of heath land, composing two farms (which had been enclosed under an act of parliament about forty years), without tenants; the gorse, heather, and fern shooting up in all parts. In short, the land was in such a condition, that the crops returned not the seed sown. The soil was a loose, loamy soil, and had been broken up by the plough to a depth not exceeding *four inches*, beneath which was a substratum (provincially called an iron pan), so hard, that with difficulty could a pickaxe be made to enter in many places; and my bailiff, who had looked after the land for thirty-five years, told me that the lands were not worth cultivation—that all the neighbouring farmers said the same thing—and that there was but one thing to be done, viz., to plant with fir and forest trees; but to this I paid but little attention, as I had the year preceding allotted some parcels of ground, taken out of the adjoining lands, to some cottagers; to each cottage, about one-third of an acre. The crops on all these allotments looked fine, healthy, and good; producing excellent wheat, carrots, peas, cabbages, potatoes, and other vegetables in abundance. The question then was, how was this done? On the outside of the cottage allotments all was barren. It could not be by the manure that had been laid on, for the cottagers had none but that which they had scraped from the roads. The magic of all this I could ascribe to nothing else but the spade; they had broken up the land eighteen inches deep. As to digging up five hundred acres with the spade, to the depth of eighteen inches, at an expense of £6 an acre, I would not attempt it. I accordingly considered that a plough might be constructed so as to loosen the soil to the depth of eighteen inches, keeping the best soil to the depth of four inches, and near the surface, thus admitting air and moisture to the roots of the plants, and enabling them to extend their spongioles in search of food; for air, moisture, and extent of pasture, are as necessary to the thriving and increase of vegetables as of animals. In this attempt I succeeded, as the result will show. I have now broken up all these five hundred acres, eighteen inches deep. The process was by sending a common plough, drawn by two horses, to precede, which turned over the ground to the depth of four inches; my subsoil-plough immediately followed in the furrow made, drawn by four horses, stirring and breaking the soil twelve or fourteen inches deeper, but not turning it over. Sometimes the iron pan was so hard, that the horses were set fast, and it esteemed in his day, pretended to be able to keep his land in a state of perfect fertility by bringing to the surface a fresh layer of earth alone; because, to use his own words, the layer of earth which is buried enjoys a period of repose, and thus renovates its exhausted powers, while that on the surface is producing crops. He stated in his work, entitled "Ooconomische," published at Leipsic in 1749, as well as in several of his other writings, that the necessity of fallows, rotations of crops, and manure, may thus be done away with. The experiments made by him on some land near Berlin, which had been granted to him by Frederick II., were, as may easily be supposed, attended with the most fatal results. Had he immediately set to work to procure manure from Berlin to ameliorate the virgin earth which he continued to bring to the surface, he might, under certain modifications, have continued to obtain crops from his land; but he had not a sufficiently definite idea of the science of agriculture, and destroyed and ruined his

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became necessary to use the pickaxe to release them before they could proceed. After the first year, the land produced double the former crops, many of the carrots being sixteen inches in length, and of a proportionate thickness. This amendment could have arisen solely from the deep ploughing. Manure I had scarcely any, the land not producing then stover sufficient to keep any stock worth mentioning, and it was not possible to procure sufficient quantity from the town. The plough tore up by the roots all the old gorse, heather, and fern, so that the land lost all the distinctive character of heath land the first year after the deep ploughing, which it had retained, notwithstanding the ploughing with the common ploughs, for thirty-five years. Immediately after this subsoil-ploughing the crop of wheat was strong and long in the straw, and the grain close-bosomed and heavy, weighing full sixty-four pounds to the bushel. The quantity, as might be expected, not large (about twenty-six bushels to the acre), but great in comparison to what it produced before. The millers were desirous of purchasing it, and could scarcely believe it was grown upon the heath land, as in former years my bailiff could with difficulty get a miller to look at his sample. Let this be borne in mind, that this land then had had no manure for years, was run out, and could only have been ameliorated by the admission of air and moisture by the deep ploughing."

Sub-Turf Plough.—"Being on the subject of the subsoil-plough," says Sir Edmund Stracey, "I may as well tell you I have contrived another plough, from the use of which the greatest benefit has been derived by my park land. I call this my 'sub-turf plough.' It is used to loosen the turf about ten inches and a-half deep below the surface, without turning over the flag. There are no marks left by which it can be known that the land had been so ploughed, except from the straight line of the coulter, about fourteen inches from each other. In about three months these lines are totally gone; the additional quantity of aftermath, and its thickness, produced from grass thus treated, have been the subject of admiration of all my neighbours."

fortune by commencing scheme after scheme without carrying out any of them. The interest, however, excited by this man, contributed not a little to direct public attention to the science of agriculture, and to induce men of talent to make experiments and engage in researches on this subject.

There is likewise a method of loosening the soil to a considerable depth without turning it over, or, in other words, without bringing the substratum to the surface, and one that is practised with great success on loose soils; this operation is effected by means of a plough without a mould-board, and having only a strong, low, convex share. This instrument passes along the same furrow as a common plough, stirs up the earth to the bottom, and thoroughly breaks and divides it. The excellent manner in which this operation is performed is probably hardly surpassed in those countries where the soil is ploughed to a depth of sixteen inches with common ploughs.

In my opinion ploughings should never be carried beyond that depth which we term moderate, unless they are intended to prepare the soil for the reception of weeded or leguminous crops. A very superficial ploughing will in general suffice for grain, or the land may merely be tilled with those instruments which tend to accelerate and facilitate labour; because when a soil has once been thoroughly loosened and pulverized to the bottom it retains its porousness and permeability for many years, especially if composed of one-half sand and thoroughly impregnated with humus.

In order to be able to form any correct idea of the number of ploughings which it is necessary to bestow on land, we must consider each of the principal rotations separately.

In most of our alternate rotations the soil is tilled before the commencement of winter to its utmost depth, or, at any rate, as deeply as the plough can conveniently be made to go. Where this depth exceeds twelve inches, recourse must be had to double ploughings. The second tillage is superficial, it being merely intended to bury the dung; and the third, or that which precedes the sowing, penetrates a little further. The land is tilled to a still greater depth by means of the horse-hoe, while heaping up the earth round the plants of weeded crops, which, in order to facilitate this operation, are sown in rows. After the crop, a skimming or paring plough is passed over the ground, and also a harrow if requisite, in order to smoothe it; and then, before winter comes on, it is ploughed slightly. It is seldom that an actual ploughing is given to land thus tilled in the spring; such an one would be both superfluous and injurious to land containing fifty parts in a hundred or more, and which has been properly prepared for the fallow crops, especially if the season proves dry. All that is requisite to be done is thoroughly to loosen the surface of the soil to a depth of two or three inches by means of an extirpator, to harrow it, to sow the grain (which is usually barley), to bury it with a small extirpator, and then to harrow the soil afresh; or, if the land is to be sown with clover, to scatter the seed, and then pass the roller over it. After bearing a crop of barley, the land is suffered to grow clover only for a year or two. The preparation for the autumnal corn consists in one ploughing of a moderate depth; but the skimming plough is likewise passed over the soil. This ploughing is performed at least a month before the period of sowing, in order that the soil may have time to sink down again, which is necessary to the success of the crop. The autumnal corn is sown without further preparation. Some agriculturists make use of the small extirpator to bury the seed, and subsequently pass a harrow over the land. In the following spring, when vegetation recommences, this harrowing is repeated when time or weather will admit of it; and in order that this latter one may be more efficacious, it is seldom that the autumnal harrowing is carried so far as to cause it to break all the clods; it is deemed better that they should remain until the spring, in order that, by then breaking them, the harrowing which takes place at that season may supply the plants with new earth.

If the autumnal corn is to be succeeded by a green crop, one or two ploughings are given to the land, according to the nature of the soil and the state of the temperature. Land is prepared for vetches (which are to be mown while green) by two or three ploughings. After the leguminous crop has been gathered in, a moderately deep ploughing is given with as little delay as possible. Shortly afterwards the land is harrowed; and before St. Michael's day the seed is placed in the ground, buried with a small extirpator, and subsequently harrowed.

If the farmer wishes to obtain a crop of oats after his autumnal corn, he bestows a slight tillage on the soil in the autumn, and in the following spring ploughs it to a moderate depth, sows it with oats, and buries the seed by the action of a small extirpator, succeeded by a harrow. This crop is sown about the middle of May, when the seeds of those weeds contained in the soil have germinated and begun to vegetate. Such are the ploughings usually given to land cultivated according to the system termed "alternate rotations," where no second crops are required from it.

In those systems of cultivation which require a dead fallow, the chief attention must be directed to that point; for as a whole year is sacrificed in order to devote to the soil the requisite amount of tillage, it would be unpardonable not to render this tillage as perfect as possible, and to endeavour to attain the purpose and intention of the fallow to its fullest extent.

A fallow ought to be productive of the following advantages:—1. A suitable increase in the depth of the layer of vegetable earth by means of deep ploughings. 2. The reversion of the earth. 3. Its pulverization. 4. Its due admixture. 5. Its exposure to the influences of the atmosphere; and 6, and what is most important, the destruction of all the weeds contained in it. If, by means of a fallow, all these advantages can be obtained, the benefits arising from it will be sensibly felt through a long series of years.

In the system of cultivation which is associated with the triennial rotation, a fallow ploughed three times is a very common, and, at the same time, a very imperfect thing. It rarely, if ever, attains the object in view. In general, the want of a sufficient pasturage for the cattle prevents the field from being broken up until the end of June. Thus, the soil only receives half a year of repose and pasturage, and half a fallow.

In those fallows which are accompanied by four ploughings, the first of these is usually given in the autumn, or before the commencement of winter; but sometimes it is postponed until the spring, which is very injudicious.

Fallows are rarely ploughed five, six, or seven times, except on the very best soils, and among agriculturists who know how to estimate their soil and to appreciate the value of this careful tillage, or who are of a sufficiently speculative disposition to induce them to sacrifice the produce of their fields during one year, for the purpose of increasing their fertility. Such a system of cultivation would, undoubtedly, be both practicable and beneficial in our climate.

The first ploughing is called the "fallow-ploughing;" and this operation is designated by the terms "breaking up," or "fallowing" land *(brackfurche)*, especially when it relates to the tillage of land that has borne grass, or been mere pasture ground. If the soil to be tilled has previously been corn land, the term *sturzen*, (to fallow) is then made use of; but this is applicable to all first ploughings.

The second ploughing is termed "re-delving" *(wandefahne)*; when it is being performed, they say that they "re-delve," or turn the fallow over. This expression is adopted in some countries, because, during this operation, the slice reversed by the first ploughing actually is turned over a second time.

The third ploughing is designated by the appellation of "stirring up" *(ruhrfarhee)*, because, in fact, it consists in stirring up the soil and bringing to the surface all those portions which had not previously been brought into contact with the atmosphere. If this ploughing is repeated, it is said that the soil is "stirred" again. The last ploughing is called the "seed-time ploughing" *(saatfahre)*.

The Romans distinguished these different ploughings from one another by certain terms. They called the first "*praescindere*;" the second, "*vertere*;" the third, "*fringere*;" the fourth, "*offringer*;" the fifth, "*refringere*;" and the sixth, or the one preceding the sowings, "*liraro*." Every nation, and almost every province, has its own peculiar denominations for these ploughings; and it is necessary to become perfectly acquainted with them, if we would acquire any information with regard to the agriculture of the country.

When repeated ploughings are given to land as preparations for spring and autumnal corn sown consecutively, each of these is frequently characterized by some peculiar term.*

Almost all scientific men are of opinion that the fallowing or first ploughing ought to be very superficial. Formerly, however, in the system of cultivation connected with a triennial rotation, a totally opposite opinion was entertained. Munchhausen, in his work entitled "Haus-vater," considered that it should be as deep as the plough can conveniently be made to penetrate. In the system of alternate cultivation and pasturage, this ploughing must necessarily be very superficial, and merely skim off and turn over the turf, since the object of it is merely to break that up. Were a thick slice turned over, it would not loosen and pulverize, nor would the turf become decomposed. As, in a triennial rotation, the fallow ploughing is seldom bestowed until late in the year, when the soil is for the most part covered with grass, it is advisable that in general it should be merely superficial. But if it takes place before the commence-

* We have here left out several technical terms which are peculiar to the German language. The author designates oats sown after repeated ploughings, by the term *Felghafer*; those sown subsequently to another crop of cereals and with the preparation of one ploughing only, as *Hartlandhafer*; and those sown on grass or broken-up pasture-land by that of *Druschhafer*.

ment of winter, the operation should be carried to the utmost depth of the soil, because the under part of the soil will thus be submitted for a longer period to those fertilizing influences of the atmosphere which are so necessary and so beneficial to it. When the agriculturist wishes to augment the layer of vegetable mould, he must do so by the first ploughing.

The soil is generally suffered to remain in the state to which it is reduced by the first ploughing during the whole of the winter, in order that a greater extent of surface may be presented for the air to act upon. This practice is peculiarly adapted to land which contains a great quantity of weeds propagated by their roots, because the roots and germs of these are much more easily destroyed when thus exposed to the air, than when buried again and covered over with earth, as is the case after harrowing it. But where the soil is chiefly infested by weeds springing from seeds, these latter may be made to spring up and vegetate before winter comes on, by fallowing the land early in the autumn, and then harrowing it. Besides, the influence of the atmosphere is not altogether impeded by this harrowing, because the air can penetrate sufficiently into the loose earth to fertilize it, and is enabled to act more powerfully on the pulverized clods than it could on hard masses of earth. The layer of herbage is, however, more completely decomposed when the surface of the soil is compact, and the air cannot get at the plants of which it is composed. In fact, when exposed to the action of the atmosphere the turf remains green, and not unfrequently sprouts out between the interstices left among the slices cut off by the plough; the decomposition of turf, therefore, whether it be thin or tenacious, will be favoured, not only by making use of the harrow in order to cover it with earth, but also by employing the roller to press it down.

It is seldom that the land is ploughed twice before the commencement of winter, however advantageous such a proceeding might be: whenever this is done, the first ploughing ought to be superficial and to take place directly after the harvest; and the second carried to the utmost depth of the soil, and bestowed a short time before the beginning of winter.

The second ploughing is generally not given until spring, and until all the sowings are effected. It should never take place too early in the year, but should rather be deferred until all the weeds contained in the soil have begun to shoot up. It is not customary to harrow the soil after the second ploughing, although this operation might be advantageous; but if it becomes necessary to defer this ploughing, the harrowing cannot be dispensed with; without it, the ground would get so hard that it would be exceedingly difficult to plough it, especially in dry weather. If the field thus fallowed had previously been pasture or meadow land, and thickly covered with herbage, the second ploughing must be performed in the same direction with the first, because cross ploughings would form the turfs into clods, which would be brought to the surface and dragged along by the harrow, and could with difficulty be divided.

When the first ploughing has been superficial, the second must be deep, in order to bring up the earth from the bottom to the surface of the soil and cover up the slice.

After such a second ploughing the harrow is always used. If the field was mere grass land before being broken up, the harrowing must be performed with heavy harrows, in order that by this means the crust raised to the surface of the field may be loosened and completely divided. In all other cases the common harrow will be fully capable of breaking down the clods.

It has frequently been asked, whether this harrowing should take place immediately after the second ploughing, or deferred until nearer to the period of the third ploughing. At this season of the year, exposure to the influence of the atmosphere is highly beneficial to the soil. If the weather be dry, the roots of the weeds exposed to the action of the sun's rays are considerably injured. Hence it would appear advantageous to postpone the harrowing; but where the soil is tenacious, care must be taken that it does not get too dry, otherwise the clods will get so hard as to make it impossible for the harrow to break them. On the other hand, when a soil is not divided, but is left in the state to which it was reduced by the ploughing, it is not so favourable to the germination of those seeds enclosed in the clods as it would be if thoroughly divided. If, therefore, the object of the farmer be to get rid of the seeds of weeds, it is requisite that the soil should be immediately harrowed, in order that those seeds which are brought to the surface by this operation may be allowed time to germinate and shoot up before the period of the ensuing ploughing.

When the width of the field will admit of it, the third ploughing should be in a contrary direction to the other two; and this cross ploughing will produce a far better division of the clods than could have been effected had the land been always tilled in the same direction. Those roots contained in the furrows previously formed will thus be detached and loosened, if not torn up; and the banks of untouched earth which are frequently left between the furrows will be cut through and broken down: this will account for the fact that land which has been carelessly or badly ploughed will always be considerably ameliorated by the operation being repeated in an opposite direction to the former ridges. The third tillage can, however, be performed much better with a binoir than it could with a plough, because the former is better adapted than the latter for the purpose of tearing up the roots of weeds, and bringing those clods of earth contained in the soil within the sphere of the action of the harrow.

The harrowing which follows this ploughing ought to be performed with peculiar care, because it is capable of producing a wonderful effect on the soil. The roots of the weeds are by this time sufficiently loosened to admit of their being dragged to the surface, and at this season of the year the sun's rays possess sufficient power to wither them up and destroy them. The observations which we made when speaking of the expediency of harrowing immediately after the second ploughing, or deferring it for a while, will be equally applicable to this case; but here, as it is highly important that the roots of vivacious weeds should be torn up, and exposed to the heat of the sun's rays previously to being again buried, this operation should be postponed for as short a period as possible.

The manure is usually buried by this ploughing, and as it is desirable that this should not be placed at any great depth below the surface of the soil, the third ploughing must be more superficial than either the second or the fourth.

If this ploughing can be performed during favourable weather, that is to say, when there has been a succession of warm days accompanied by showers, this circumstance will be found to have considerable influence not only on the ensuing crop of cereals, but also on the whole rotation; and, in fact, the reciprocal action of the soil and the manure is then considerably augmented. Those weeds springing from seeds, as well as those propagated by their roots, are then much more completely destroyed and eradicated than they possibly could have been had the weather proved cold or damp. It is, therefore, highly necessary that this operation should not be deferred longer than is absolutely unavoidable, and that it should be performed during the hottest part of the summer.

If too much rain does not fall after this tillage, and the arrangements of the undertaking will admit of it, it will be highly beneficial to stiff clay soils to bestow another ploughing on them; the durable amelioration of the land thus obtained, and the improvement and augmentation of the crops yielded by it, will amply repay the expense of such an operation. When this last mentioned tillage is performed by means of a binoir, the land is tilled in a cross or contrary direction; but if the plough is made use of, such a course of proceeding is almost impracticable, on account of the inconveniences attendant on having to turn so frequently.

Lastly, the seed fallow, or that ploughing which is to precede the sowing, may be performed either with a plough or a binoir. This operation is made to penetrate to the utmost depth of the soil, unless, as is sometimes the case with wheat, although it never should be with rye crops, the seed is to be buried with the plough. This operation ought to be performed as carefully and evenly as possible. Should any inequalities still exist on the surface of the soil, a harrow may be passed lightly over it, after it has been suffered to remain for a while in the state to which it was reduced by the plough: this must be done in order to prevent the seed from falling into deep holes, or from being amassed too thickly in rows, which always injures the crop. It is seldom, however, that this occurs excepting on land carelessly ploughed. The seed is buried by means of cross-harrowing, or, where it can be managed, of round harrowing. There are various contradictory opinions existent respecting the propriety of using the extirpator rather than the binoir, to give the ground its last tillage preparatory to sowing the seeds. It appears to me that the latter instrument is by far the most preferable, because where it is made use of there is less danger of the seed becoming accumulated in the furrows: but then some means must be taken to prevent the cattle from walking on the ploughed land.

When the second ploughing has been performed during favourable weather, and carried to a proper depth, all the succeeding tillages may be effected by means of the extirpator; the operations can be much more quickly performed with this instrument, and it is decidedly superior to the plough on all soils of a loose nature. The promptitude with which the tillage can be effected by it enables the farmer to select the most favourable period for the performance of each operation; it breaks the clods, too, much more completely, and thus enables the seeds contained in them to vegetate sooner and be destroyed with less difficulty. Unfortunately, this instrument cannot be made use of for the purpose of burying common stable manure: where this has to be done, recourse must, therefore, be had to the plough; but if the manure merely consists of a thoroughly decomposed compost mixture, or of lime, the extirpator will be found peculiarly serviceable.

There doubtless are many countries in which the farmers have not the least idea of the necessity of bestowing this amount of labour and attention on a fallow. The being compelled to reserve some pasturage for the cattle during half the summer, however poor and scanty it may be, obliges, or at any rate inclines, many agriculturists not to break up the ground for the purpose of fallowing it until towards the end of June, and to continue this tillage in July; then there is not a moment to be lost if we would plough it three times without deferring the sowing, the more especially as this is the period at which the manure is carried. These three ploughings may be sufficient to loosen and divide sandy soils, and render them thoroughly homogeneous; in fact, it is not improbable that too great a degree of tillage bestowed on them would tend to injure rather than benefit the ensuing crops, by depriving the land of its adherence and consistency. But three ploughings are far from being sufficient to eradicate all the weeds, consequently, in such places the soil is overrun to a dreadful extent with every description of weed, and especially with couch-grass: this is accounted for by the ploughings being so near together as not to allow time for the seeds contained in the clods to germinate. Besides, the manure cannot be sufficiently divided and mixed up with the soil to enable the first crop to derive those advantages from it which might otherwise be obtained. It not unfrequently happens that on fallowing land which has been thus tilled, lumps of dung are found similar in appearance to peat, and which can with difficulty be broken. It is on land thus cultivated that it may with truth be asserted, manure produces less effect on the first than on the second crop. For the sake of a scanty pasturage the farmers forego all those advantages which might be attained by the sacrifice of the produce of their land for one whole year. Necessity may be pleaded as an excuse for this error, but whence arises that necessity?

The usual preparation for spring corn is three ploughings; and in order to have time to give these, the land is broken up in the autumn after the sowings of that season are completed. It is seldom, however, that the ground is broken up immediately after the harvest, even in agricultural undertakings where this is practicable: the old proverb, "Let the plough follow the sickle," ought to be attended to oftener than it is. But whenever this is done, the land may be ploughed a second time before winter comes on,* otherwise that operation must be performed as early in the spring as the weather will permit. Properly speaking, the second ploughing ought to be deeper than the first, and to be succeeded by a harrowing; a third ploughing must then be bestowed on the land, and this succeeded by a fourth, which is intended to bury the seed, unless heavy rains prevent it.

This ought to be the preparation for the spring sowing, but it not unfrequently happens that weather or want of hands prevent the farmer from giving it, and he is forced to content himself with two ploughings, the first of which is very imperfect. Oats and large two-rowed barley are frequently sown with this scanty amount of tillage, because the farmer fears that if he stops to give more they will not be got into the ground soon enough. Small spring barley, in four rows, need not be sown so early, and it is probable that it is on this account that it is preferred in those places where the triennial rotation is in full vigour; in fact, in this rotation it is so necessary that three ploughings should be bestowed on land intended for the reception of barley, that the farmer must

* I find it an excellent practice to till my fields once or twice with the extirpator immediately after harvest is over. This does not occupy much time, and the seeds of those weeds which have shot up during the growth of the autumnal corn have then time to germinate before they are too deeply buried. In fact, I cannot expatiate too largely on the advantages which I derive from the use of the extirpator, and especially of that one improved by M. Fellenberg.—FRENCH TRANS.

not be deterred from giving them, by any fear of the evil consequences which may result from such a late sowing. The tillage bestowed on land in the spring as a preparation for barley, frequently contributes far more to loosen the soil than one ploughing at the end of autumn given to land which is to be fallowed in the ensuing year, especially if the spring is dryer than the latter end of autumn was.

The practice of *half ploughing* is frequently had recourse to for the purpose of fallowing land. This operation consists in raising slices of earth with the plough, which are turned over on strips of untouched ground, which latter alternate with the furrows emptied by the plough throughout the whole of the field, and are covered by the furrow slice; but the slices must be rather wider than the strips of earth if we would have the latter entirely covered by them. This practice facilitates the decomposition of stubble, the action of frost on the ground, and the loosening of the earth; it enables the harrow to act more efficiently on the following spring, to tear up the couch-grass and other weeds, and to divide the soil more completely. But this operation must not be delayed too long, otherwise, on land thus tilled, the slice which covers the strip will have entered into vegetation with it, and there will be great difficulty in levelling the soil. This mode of ploughing prevents the land from suffering from excess of humidity, because the water runs into the furrows left open by the plough and leaves the slices dry. Sometimes after the harrowing the operation of half ploughing is repeated; but on this occasion the order is reversed, the strips are transformed into furrows, and the slices raised from thence are inverted on the places previously occupied by the furrows.

But wherever it is practicable to plough the land across, that will be even more beneficial than a second *half-ploughing*.

The operations of ploughing require constant attention from the farmer, or from the person who has the management of the undertaking; they must, in a manner of speaking, never be lost sight of, even though not always able to be present. If he has several ploughs at work, he ought to put each one under the guidance of some labourer, and on no account to forbear testifying his displeasure if he finds the slices carelessly turned over, or the furrows crooked or uneven; should he fail to do this, the same spirit of negligence will soon pervade every portion of this operation.

The first ploughing requires the greatest attention; every possible care must be taken to make the slices of equal width and depth throughout. Next to this operation, the one which precedes the sowings requires most precision; the intermediate ploughings are of comparatively but little importance. Should it be necessary to perform several ploughings on different parts of the farm at the same time, the most skilful labourers must always be picked out for those just mentioned.

Both the eye and hand of the master should invariably be put in requisition, to see that all the ploughs are in proper working order, even though the care of all the agricultural implements may be the province of the inspector of the in-door operations, or the overseer or head labourer.

In order to make sure that the labourers shall execute that quantum of work which they ought to do and are able to perform in a given time, it is desirable that large extents of ground should be divided into portions by driving in stakes, or by parcelling out the soil into a certain number of beds; such a division will also be found useful for distributing the manure, the seed, and various other operations.

In large agricultural undertakings is it advisable to employ several ploughs on one bed, or to divide them among the different ridges? There are many farmers who make use of ten or twelve ploughs one after another, and thus plough tolerably large beds of land in but few plough-lines; this plan is adopted in order to render the task of overlooking the labourers one of less difficulty, and to enable one bailiff or overseer to direct the operation of all the instruments at once, and superintend the ploughing. Others either only put one plough on each ridge, or at most not more than two or three: this is my practice. The latter appears to be the best mode of proceeding, when we come to consider that if several ploughs are at work one after another they will all be stopped by the slightest disarrangement of the foremost one. Besides, while thus working after each other one will cover the faults of another, so as to render it impossible to discover which of the labourers work well, and which badly; the master or overseer is consequently unable to appreciate the degree of skill manifested by each of his men. It is impossible to make teams and labourers work together whose activity, strength, and skill are not equal. Lastly, unless the beds are left unfinished, almost all the ploughs are obliged to stand still while one or two of them are finishing the operation.

It is easy to distribute several ploughs over the same field, and yet allow them to be sufficiently near together to admit of all being under the surveillance of one person, without putting them on the same bed or ridge; all that is requisite to be done is carefully to mark out the ridges, and allot to each plough its own.

The borders or mounds of earth at the extremity of the ridges, and on which the team turns in order to commence a fresh furrow, require particular attention and examination, because the pressure of the feet of the cattle on those parts hardens the earth excessively. If the land is ploughed outwards, in order to form a ridge, they frequently oppose a high bank to the drainage of water; if the ground is ploughed inwards the water collects in the middle furrow; it is better, therefore, to give them only one inclination, or, in other words, to turn over all the slices on the same side.

Ploughing can only be productive of all the advantages which it is capable of producing when the ground is in a proper state to benefit by that operation; that is to say, when it is sufficiently dry and friable, and inclined to divide. When the soil is moist, so much so that the slices adhere together, and the friction of the plough forms a shining crust, which when dry becomes extremely hard, it divides into lumps harder even than the soil was before it took place; and these lumps part again into clods of various sizes, which it is almost impossible to break until they have been acted upon and restored to their primitive permeability by the action of the atmosphere and of frost. It may easily be supposed that such a ploughing neither destroys the weeds themselves nor such of their seeds as are contained in the soil; the couch-grass is only multiplied by being cut; besides the labour of this operation, which is in itself so useless, is very fatiguing to the draught cattle. On the other hand, the ploughing is equally laborious, both to the labourers and to the cattle, when the ground is too dry, especially if badly constructed wheel-ploughs are used; the soil does not in this case divide equally, but splits into clods. Nevertheless, with the help of good implements, and with an accession of draught power, the operation can be performed under these circumstances; and the only inconvenience attendant on the ploughing of dry soils is the expenditure of time and labour; for the clods just spoken of fall to pieces as soon as ever a heavy rain comes on, and form a very permeable and friable soil. In all cases it is of the greatest possible importance that the period at which the soil possesses that degree of humidity which is most favourable to the operation should be chosen for the ploughing of stiff clays. And as this favourable degree of moisture does not pervade whole farms or even whole fields at the same time, it requires constant and vigilant attention on the part of the farmer to enable him to seize on the exact moment which is propitious to each particular spot.

It is by his attention to these minutiæ that the scientific is distinguished from the merely practical agriculturist; and this circumstance alone will frequently render the crops of the former far superior to those of the latter. The places which are most difficult to be ploughed ought to be taken at the most favourable period, and all the manual and draught power which the farmer has at his disposal brought into play for the purpose; it is often of the utmost importance that not a single day should be lost.

The English [in some counties—ED.] designate that state of the soil in which it is exactly fit to be ploughed, by the word *tid.* They say "the soil has now the *tid,*" or "the land was ploughed or sown at good *tid.*" Our labourers say "the soil is now *gaare,*" or it has been ploughed or sown at the most favourable period. The French say "the soil is now *de prise,*" or "it has been ploughed" *en bon temps.*

It is necessary to select the moment for harrowing with even more care than that for ploughing; the state of the soil will always determine the expediency of performing the harrowing at once, or deferring it to some future period. It is, doubtless, exceedingly desirable that the soil should be left for a certain period in the state to which it was reduced by the action of the plough, because it is then brought into closer contact with the atmosphere, and a great portion of the weeds contained in it, as well as their roots, withered and dried up; in general, therefore, it is better not to harrow the soil immediately after the ploughing. I should not, however, advise any one to postpone the harrowing until a few days before the ensuing ploughing, because in that case those seeds of weeds contained in the soil have not time to germinate; besides the roots of the weeds cannot then be so easily separated from their hold in the soil and pulled up. Hence it will appear that the best period for harrowing is, as nearly as possible, the middle of that space of time which intervenes between one ploughing and another; but this must not be thought to be applicable to every kind of soil indiscriminately, and can only be considered as a general rule when applied to such as do not resist the action of the harrow when they have got rid of their superabundant moisture.

Tenacious soils which become harder the more they are impregnated with water, require that the exact moment when they can be divided with least difficulty should be embraced for harrowing them; it is dangerous to allow this to pass by, especially if the temperature seems settled; thus it is often advisable to harrow land on the same day on which it is ploughed. It is on this account that in some countries, the soil of which is of an argillaceous nature, it is customary to attach a third horse to the trace of the right-hand horse attached to the plough, which animal draws a little harrow, and thus divides the soil immediately after the plough has passed over it. Young horses which require training, or weak animals, are employed in this work.

ON CLEARING LAND.

It is seldom that uncultivated land can be ploughed until after it has been cleared; nevertheless, we have permitted our instructions with respect to the former to precede those relating to the latter, because they constitute an introduction to what we shall now have to say; and, besides, a farmer always ploughs the arable land he has already, before he attempts to clear and take in fresh portions.

In order not to separate the various portions of this subject, we must here enter into an examination not only of the manner in which the operation of clearing should be conducted, but also of those financial considerations which must not be lost sight of in such an undertaking.

That the chief part of waste land might be turned to advantage, is a question which admits of no doubt whatever. Land covered with furze; the soil of ancient forests overrun with this plant, or covered by stagnant water; those moving sands which are often carried from place to place by the wind, and threaten destruction to the neighbouring country; neglected tracts which yield nothing at all, or at most but a scanty return; in short, almost all kinds of land are susceptible of some kind of tillage, and capable of yielding certain varieties of produce. But operations of this nature are not always attended with profit; on the contrary, it often happens that land thus brought into cultivation eventually costs as much, if not more, than it would have been necessary to give for the purchase of such as was already in a state of cultivation.

Even when the plan of proceeding in conducting these operations is such as positively to ensure success, the outlay of money which they require, and the time which they occupy, are so considerable, that whoever thinks of undertaking such improvements should, in the first place, carefully consider whether or not it will be in his power to carry them out, and whether, during their progress, he may not find cause to regret the expenditure of so much labour and capital upon them. Both public and private interest demand that undertakings of this nature should rather be left altogether unattempted than abandoned in the middle or imperfectly executed. It often happens that those sacrifices which have been made for the sake of bringing fresh portions of land into cultivation, are not followed by any satisfactory returns, because they have not been carried out to the requisite extent. Indeed, it is by no means uncommon for land thus treated to become even more sterile than it was before. A pasture capable of keeping sheep, or land on which bushes and small trees grew, may by these means be reduced to the condition of a barren waste. Such occurrences frighten and discourage the descendants of those who have engaged in such speculations for several generations, and cause them to blame their ancestors for having deprived the other lands on their estate of that cultivation and manure which would have benefited them so materially, and wasted it in a vain speculation.

When, therefore, such an undertaking is in contemplation, it is of the utmost importance that all the circumstances connected with the locality in which it is to be executed should be carefully examined, and an exact estimate of what may be the value of the land, and how much that may be influenced by position, &c., made. It must also be considered under all the relations pointed out in the treatise on "Agronomy," and in that division which relates to the "Valuation of Estates."

It is also necessary to inquire whether we possess an absolute right of property over the land; whether we can dispose of it by legacy or by sale; or whether, on the other hand, we possess but a limited right in it. All liabilities attached to the soil, or taxes based upon the amount of produce which are likely to intrench so largely on the returns as to exceed the profit arising from the improvement of the soil, and thus annihilate the advantages which might have been expected to accrue, must be taken into account. Tithes too often actually destroy the profits.

It is likewise necessary to be well assured that the requisite number of labourers for carrying on the work can always be procured in the neighbourhood, and also that the labour which may be expected from them is proportionate to the wages which they demand; whether it is necessary to provide oneself with the teams which will be required, and maintain them upon purchased fodder, or, on the other hand, whether the beasts of draught which must be employed in the operation, can be hired in the neighbourhood. Finally, and this, perhaps, ought to be the first consideration, whether we shall have at our disposal for a sufficiently long period the amount of capital requisite to cover all the outlay, and whether we can dispense with the interest of it during the whole time that the improvements are in progress.

There are two cases, in particular, which require to be well distinguished. Either the clearing is to be performed in the neighbourhood of an agricultural establishment already organized, and carried on in connection with it, so that it may be performed with the same teams, labourers, and resources, and at the most convenient periods; or an entirely new establishment is to be organized upon the very soil submitted to the operation, and the agriculturist has to look to that soil for the means of cultivating and improving it.

In the former case, the difficulties to be encountered are not so great as in the latter. Nevertheless, it is necessary maturely to consider in what manner the land about to be brought into cultivation can best be placed in connection with the existing establishment, and to determine to what extent the old and new portions of soil will be able to assist each other; how they can be blended together so as to form a well-regulated and well-proportioned whole; and, above all things, carefully to inquire whether the nature and situation of the land about to be enclosed will admit of its being subjected to the same rotation as the rest, or whether the system of cultivation employed on it must be different from that of any of the rest of the farm lands.

In effecting such an addition to the land, it is not unusual to fall into one of two extremes.

Sometimes the old land is neglected from a predilection for the new and the entire resources of the estate exclusively devoted to the latter, to the manifest detriment of the whole. The consequence of this is, that the net profit is often diminished during a long series of years; or, on the other hand, and most frequently, the new land after having been broken up is treated merely as an accessory to that portion previously in a state of cultivation. It is exhausted, deprived of all its nutritive principles and power by being made to bear a series of crops intended for sale or for home consumption, without rendering back to the soil from whence they sprang the manure arising from it. This mode of proceeding is based upon the erroneous supposition that the soil naturally contains a sufficient quantity of nutritive matter to enable it to produce a succession of crops; and when this is exhausted, a moderate manuring with dung will restore it to a state of fertility. Experience has, however, clearly proved, that when newly cultivated soils have been thus impoverished, they do not recover their condition until after having been repeatedly manured, and without such treatment actually yield no profit. Under such circumstances, they are usually abandoned in their exhausted state as barren and useless soils, incapable even of affording a scanty sustenance to sheep, and are made use of as scare crows to frighten other persons and deter them from entering into speculations of a similar nature.

The rule which it is most important to observe, and which can never be transgressed with impunity, is to endeavour to derive a sufficient quantity of substantial fodder from the newly cultivated land to admit of a larger number of cattle being maintained. Unless this land consist of an alluvial soil of great natural fertility, it will be necessary to cause it to bear at least two crops of fodder, or else be laid down to grass during that period; for each crop of corn obtained from it, and the whole of the manure resulting from the consumption of its produce, must be bestowed upon it. If this is not done, an equal extent of the old fields must be laid down to grass, instead of the newly cleared land, and the manure produced by the cattle fed upon such pastures devoted to the improvement of the latter. But under such circumstances, even though the plan thus described may be capable of effecting the fertilization of the newly cleared lands, still, if the earth of which the soil is composed be of a very light and porous nature, it must not be submitted to the action of the plough for several successive years, unless care be taken to alternate the corn crops with crops of clover and other fodder plants; otherwise the land will be deprived of all its consistency. In a word, in the distribution of newly cleared land, we must endeavour to give to the whole of the agricultural establishment that equilibrium and those just proportions which will ensure its success, and avoid all risk of disturbing the harmony of the whole.

The difficulties to be surmounted are much greater when the operation of clearing has to be undertaken in a remote situation, and a new agricultural establishment founded and arranged on the land itself. In such cases, it is perfectly impossible to do without cattle, if we would bestow that quantity of manure on the soil which is indispensable to its fertility; these cattle cannot be maintained without an adequate supply of fodder, and the fodder cannot be raised unless the soil is manured and tilled. These things are naturally dependent upon one another: it is therefore necessary, in the first place, to bring the soil into a productive state; and this is the foundation of the whole undertaking. Consequently, we may consider it as an invariable rule and fundamental principle, that in the first place, a portion only (greater or less according to circumstances) of the land which is to be cleared shall be broken up and brought into cultivation, and then the clearing be gradually extended to the remainder; the first portion must be brought into as good condition as possible, by bestowing upon it all the labour and manure which it requires, in order that it may be able to produce those crops which will serve to supply the subsequently cleared pieces of land with the manure necessary for their fertilisation, and thus serve as the basis of the whole undertaking.

If the teams required for the execution of the tillage operations of the first portion of land can be hired in the neighbourhood, it will be found more economical to employ them, although paying highly for them, than to keep teams belonging to the establishment; unless, indeed, employment can be found for the latter throughout the whole of the year. If the proprietor should have an agricultural establishment at no very great distance, it will perhaps be most advantageous to send the teams from thence to the new estate, during that portion of the year at which they can best be spared.

It is seldom that cattle can be maintained at first, on account of there not being a sufficient supply of that kind of fodder which they require, and because, if they were purchased under such circumstances, they would eventually cost more than they would repay. Sheep, on the contrary, may almost always be maintained, for no one would think of attempting to cultivate spots so barren as not to be capable even of yielding a scanty sustenance to these animals. Should there not be a sufficient quantity of fodder at first for the maintenanceof the sheep during the winter, only such as are intended to be slaughtered must be kept. But the requisite amount of pasturage will soon be obtained if the animals are penned on the land which has been sown with fodder plants, and if only such plants have been sown as are of rapid growth, as spurry, radishes, rape, buck-wheat, &c., and the sheep that are fattening are made to eat them while green. After these plants have been gathered or eaten off the ground, the sheep must again be penned on it; and subsequently it may be sown with grain, intermixed with red or white clover, according to the nature of the soil, in order to obtain fodder from it or leave it as pasture land. When a portion of the land to be cleared has thus been brought into a state of cultivation, the clearing may be continued from year to year; and the establishment will soon be in a sufficiently prosperous state to be able to support horned cattle and produce stable-manure.

When a soil which has been left for some years in the state of pasture land, after having been previously sown with clover, is broken up, plentiful crops will be obtained from it; and this portion will yield not only corn enough for supplying the establishment with bread, but also the quantity of fodder requisite for the maintenance of the horses; and then is the time to effect a complete and perfect organization of all the several parts of the establishment.

At the commencement of such an undertaking, the first and only point to be attended to is, the means of obtaining fodder, and through it manure. It will, generally speaking, be necessary, for a considerable period, to abandon all idea of obtaining any net profit; indeed, it will rather be desirable to devote a second amount of capital to the tillage of the land which we wish to improve and bring into cultivation, and advance certain sums for that purpose, which may, however, be gradually diminished every year. This outlay, and the interest which it would have yielded under investment, will be amply repaid by the increase of produce which will eventually be obtained from the soil.*

From what has already been said, it will be evident that the operation of clearing and improving land, when executed upon soils of ordinary fertility, absolutely requires a command of pecuniary resources, united with a great deal of ability, zeal, and patience. No person ought, therefore, ever to undertake it who is short of money, or who is not largely gifted with experience and perseverance; although it too often happens that persons who possess least of all these qualifications, are the very men who engage in such speculations. Many agriculturists have been completely ruined by operations of this nature; even when the soil on which they worked was of a very good quality, they have been compelled to abandon the enterprise without bringing it to a favourable conclusion. Under the most favourable circumstances, the soil does not attain any great degree of fertility, if from any cause it has been impossible to bestow the full amount of outlay which it requires, and of tillage upon it; unless, indeed, it is naturally possessed of an almost inexhaustible quantity of nutrition and richness, as is the case with the marshes of the Odor and the Wartha.

At all events, clearing of land is an undertaking not at all adapted to the circumstances and resources of small farmers, or of the peasantry. Even if any one were inclined to assist men of this class in such operations by pecuniary advance, they would be unable to extend their views through a long series of years; they would require to reap the fruits of their labour at once. There is certainly every reasonable ground for expecting a speedy return of capital when the soil to be cleared has been for years old forest or pasture land, supposing that an exhausting system of cultivation is resorted to, and the land by repeated ploughings, without any attempt at obtaining

* See the "Annalen des Ackerbaues," 1808, vol. vii. p. 313, in which will be found a detailed account and estimate of a project for clearing an extent of uncultivated ground.

the means of maintaining cattle and procuring manure, is made to produce a rapid succession of crops intended for sale. But it must be remembered that such a course of proceeding will soon reduce any soil, however naturally rich, to a state of absolute sterility; and that when in that state it certainly may be made to keep a few sheep from absolute starvation, but is incapable of nourishing or fattening them. There is no country in which so great an extent of waste land has been brought into cultivation within the last half century, as has been in Scotland and the north of England. In both these countries the clearing has been for the most part successfully performed by societies instituted expressly for the purpose, the members of which actively interested themselves in the matter. These societies purchased an extensive tract of land, and caused it to be cleared under the superintendence of a very able man: then, when it had been prepared for tillage, and, in many cases, not until it was actually brought into a state of complete cultivation, it was sold in separate portions, either with or without the buildings, or else farmed out. But, on the other hand, these clearing operations have never been successful when the land has been parcelled out before the clearing was performed; for the petty farmers have then, as in our own country, been invariably ruined.

When some substance adapted for the purpose of manuring the soil is found upon it, as marl, mould, peat, lime, &c., the clearing may be accomplished in much less time. The operation is equally facilitated when irrigated meadows can be formed by stopping the course of small rivers or brooks, or accumulating the waters of springs; when such accessories can be attained, they should always be attended to at once.

The first things to be done are carefully to determine on the manner in which the land about to be cleared can best be turned to account; to lay down a plan of operation which is drawn up with due regard to the nature of the soil and the ends proposed to be derived from it; and to precisely and perseveringly adhere to such a plan when once it is arranged. It is highly important that the improvement of the land should be commenced at that part which is most capable of being converted into meadow or pasture ground, even though it should be determined to submit this land to the plough at some future period; by so doing, a supply of manure will be ensured; and the fertility of those portions of land subsequently cleared will be increased.

It is upon the soil of ancient forests that operations of this nature are usually performed, and it is upon such soils that they are attended with the greatest advantages and success, both as regards the person by whom they are undertaken and society in general. The preservation of old decayed forests is not at all likely to remedy those evils which are constantly complained of, arising from a scarcity of wood. To remedy this evil it is rather necessary to pull up all sickly and isolated trees, to extirpate bushes, and establish thickly planted and well-enclosed forests. There are many countries possessing little forest land in which a scarcity of wood is not more felt than it is in others in which forests and woods occupy a considerable portion of the surface. In many cases it would be advisable and beneficial to enclose and convert into plantations those corn lands which have been well cultivated, but have become exhausted; and thus gradually extirpate and replace the old forests, and convert them into corn lands. The soil of forest land usually contains a sufficient quantity of nutritious matter to enable it to produce both crops of fodder and of corn, even without being manured with dung; and, consequently, will yield an immediate return for the expenses of clearing, without being exhausted by so doing.

It cannot be denied that the extirpation of trees and bushes often requires a great deal of labour, and, therefore, various machines have been invented for the purpose of performing the operation with greater facility. But these contrivances have not as yet exhibited any decided advantages; and it now appears to be a well-attested fact, that it is not in the power of mechanical science to invent any machine possessed of sufficient force to up-root large and old trees.

The clearing of wood and forest land is in general performed by task work, the price being regulated either by acres, or by the number of cords or fathoms of wood resulting from the process. In this case, care is taken to stipulate definitely that the ground shall be cleared of roots as thoroughly as possible: very frequently the heads of the trees, or, in other words, the portion of the lower part of the trunk from which the roots grow, or from which the stem is separated, are given as payment for the labour of clearing land.

When the ground is overrun with the roots of black-thorn, brambles, or even by the stumps of oak, elm, ash, or maple trees, it is very difficult to clear it so completely as to prevent the roots from throwing up new shoots. The trouble of this may be saved if the ground is to be suffered to remain for several years as pasture or meadow land; it will then be sufficient, after having torn up the principal roots, to cut away the smaller ones to a depth of a few inches below the surface of the soil, and then to level the ground as evenly as possible. If the roots throw up fresh shoots, these latter will usually be very vigorous on the first year; but then they may be mowed at the same time with the grass as close to the ground as possible, and the quantity of hay is thereby increased. On the second year the number of shoots put forth is greater, but they are more weekly, and the roots themselves rarely survive the third year; in most instances they decay and die away, and thus become converted into manure. When this has taken place, there is nothing to prevent the land from being submitted to the action of the plough, and well turned up. If, on the contrary, the soil be converted into corn land before it has been carefully cleared of all the roots contained in it, the latter, favoured by the tillage, put forth their shoots with great vigour, and their extirpation then becomes exceedingly difficult.

Next to the soil of ancient forests, waste lands and common pasturages, are most generally cleared, after having been parcelled out among those persons who can lay any claim to them, or after these persons have been authorized to bring their land into a state of cultivation. Land of this description is usually in a most disordered condition, the surface being rugged and uneven, and covered with mole-hills, ant-hills, and old stumps of trees and bushes. In the clearing of forests, the greatest difficulty is presented by the roots of the trees; but in the lands of which we are speaking, the main point to be overcome is the turf, which is always more compact and tenacious than that which is formed under the shade of trees, or has been constantly covered with leaves.

Many agriculturists have found great difficulty in destroying a tenacious and uneven layer of turf; there have, in fact, been some who were absolutely dismayed by the difficulties attendant on such an undertaking. Hence it has arisen that several plans have been devised for the purpose of attaining this end with greater facility, some of which have been put into practice. The following are some of the principal of them:—

1. The first, and that which is in most general use, consists in effecting the destruction of the turf by a year and a-half or two years fallowing. The turf is broken in the autumn, or after the ground has been sufficiently impregnated with rain, and care is taken in the first ploughing not to turn up the soil to a greater depth than that occupied by the roots; supposing that the surface is sufficiently even to admit of the attainment of that end. The following method has been very strongly recommended to me for the purpose of effecting this removal of the crust of the soil, but I have not as yet put it in practice:—A plough is to be used having a very sharp coulter and share, and no mould-board, which, consequently, cuts the turf vertically and horizontally without turning it up; behind this plough, in the same furrow, and arranged so as to penetrate to the same depth, follows a second plough, having a mould-board: this latter detaches the cut portion of the turf, and turns it completely over. It is evident that this mode of operation is calculated to succeed wonderfully well; but I have never yet

met with any turf that could not be broken by the first operation of the plough, especially if, in cases in which the inequality of the surface prevented the cut portion from being completely reversed, I caused the plough to be followed by a labourer whose business it was to assist the turning up of the soil with his foot or with a pitch-fork. Whatever may have been the tenacity of the turf, I have never harnessed more than two horses to the plough used for the performance of this operation: indeed, I have often employed only oxen. Oxen are not, however, so well adapted for this work as horses, when the soil contains a great number of roots; because, though they certainly pull regularly, they are too apt to suffer themselves to be arrested by obstacles. Moreover, it will readily be understood that when cattle are employed on this work, it is necessary to feed them well, and to diminish the period of labour. If the layer of turf is very thick, it will be beneficial, first, to pass a harrow over it in the same direction with the ploughing; and, subsequently, to roll it with a heavy roller, in order that it may be withdrawn from the action of air and light, and, consequently, putrefy and decompose, instead of putting forth new shoots. If any portions of an uneven surface should escape the action of the plough—an evil which, in many cases, is unavoidable—they must be broken with the spade or hoe, or they are liable to prove very injurious.

The soil should be left in this state during the whole of the winter, and even longer, until it has been watered by the warm rains of spring. During this interim, the harrow may, however, be passed over it a second time.

When the upturned turf begins to look green again, and to put forth new shoots from its roots, we may conclude that the lower part is dead. It is, however, necessary to obtain some more decisive proof of this before using the plough; for it is not advisable to turn up the ground a second time until such is actually the case.

The second ploughing must then be performed in the same direction as the first, but penetrating rather more deeply, in order that the divided portions of turf may be covered with a certain quantity of the lower stratum of earth. It is very injudicious to perform this second ploughing cross-ways, because the furrow slices are by that means cut into square pieces, which escape the harrow and cannot be divided by it. But if the furrow slices of earth, the tenacity of which is often diminished by fermentation, are merely turned up, the use of a large harrow will be productive of complete success, especially if this instrument is drawn by four horses and furnished with long teeth, and provided that its action is continued until the tissue formed by the roots has been divided as completely as possible.

The third ploughing should be in an opposite direction to the other two, and should be executed with care and regularity; and subsequently, after a small harrow has been passed over the soil, it should be left in repose until it begins to put forth grass, when it should be ploughed a fourth time, and after that the autumnal corn sown.

This complete summer fallow will be sufficient thoroughly to loosen and clear any soil that is of a warm, dry nature, and not excessively overrun with weeds; but it will not be sufficient for a moist cold soil, the surface of which is uneven, and which is greatly infested with weeds, or with roots possessing a considerable degree of tenacity, life, and vitality. Nevertheless, many agriculturists do not go beyond this mode of operation, and make a point of sowing their land in the autumn, whatever may be its state and nature.

Where such is the case, the corn succeeds very well in some places; while in others it altogether fails, or is choked up with weeds. Satisfied with the crops obtained from the first-mentioned spots, these men hope soon to see it extend over the whole of the rest of the land. It cannot, however, be denied, that the losses which must result from so defective a system of tillage greatly exceed the advantages derived from this anticipated crop, and that it would have been better to have continued the fallowing for another year, in order to render the preparation and loosening of the soil more complete. At all events, I would never, in such a case, sow the autumnal corn; but rather plough the land two or three times more before hand, and then, during the summer, cause it to bear a crop of plants, the perpendicularly descending roots of which, and the thick shade of their leaves, might lighten and enrich the soil; such as leguminous plants, buck-wheat, and flax, which succeed remarkably well on rich soils, though they exhaust them a little. Potatoes, radishes, and other weeded crops, are likewise productive of this beneficial effect. I should not, however, cause these to be succeeded by autumnal corn, but rather sow spring barley, intermingled with clover, which I should suffer to remain for two years. I am convinced that it is by pursuing this course the soil may, with the greatest degree of certainty and success, be brought into a state of permanent fertility. I have observed that clover seldom if ever succeeds on newly cleared lands, when the soil has not been prepared by the cultivation of a fallow crop.

2. The second method above alluded to consists in sowing a crop of spring corn, after having given one deep ploughing to the land. It will be understood that this practice can only be carried into effect upon a soil, the surface of which is tolerably even, and not in any great degree infested with weeds; and, moreover, that the ploughing must be performed with great care. Oats are generally preferred for this purpose; because, if they are sown pretty thickly, in rows, and in good time, and afterwards well buried by harrowing, they succeed remarkably well, and produce plenty of grain, if not a large quantity of straw, provided always that the weather and temperature is favourable to them. Barley would not answer at all upon a soil that had been so little loosened. Many persons assert that they have obtained the greatest advantages from practising the system here pointed out; and that when their land had been cleared of stubble, after the gathering in of the oats, they found it to be more completely loosened than it would have been by fallowing; so much so, indeed, that they were able to

sow it immediately with rye. Others, and myself among the number, have found the turf so little decomposed, and the soil so imperfectly divided and loosened after the oat-harvest, that fallowing appeared indispensable; besides, the crop of autumnal corn which followed the oats was far inferior to that which might have been expected, had the grain been sown immediately after the clearing. Nearly all the comparative experiments which have been made upon this subject tend to discourage the adoption of oats as a first crop.

On the other hand, I have, in common with other agriculturists, derived the greatest advantages from sowing flax upon the turf of a piece of cleared ground, after it had been well turned up, and when the soil was not too dry or too poor. This flax always attains an extraordinary length, and is of a particularly good quality. It is equally rich in fibre as in grain, and possesses this great advantage over that sown on fallow ground, namely, that it requires very little weeding. I put in the seed of this crop with the harrow, which covered it up very well, even though the plough had brought to the surface but a very small quantity of the earth beneath the layer of turf, properly so called.

When the soil appeared too dry to admit of the success of flax, I sowed millet in it, which, when cultivated with the hoe, or by hand labour cleared of the greater part of those weeds which had sprung up among it, and somewhat thinned, succeeded admirably.

These two crops of plants always left the soil so light and friable, that the ploughing performed for the purpose of clearing away the stubble was sufficient to divide it completely, and the autumnal grain was sown upon it without any further tillage. This mode of proceeding is, however, only practicable when the stratum of turf does not contain too many asperities.

3. The third mode of proceeding is to remove the crust of the earth with a hand-implement or plough adapted for the purpose, divide the turf into pieces, and place them in heaps with stable manure or lime, which

will assist in the decomposition of the vegetable matter, and then leave them in that state until the decomposition is completed; during this time to plough the soil which has been thus pared several times, subsequently to spread the compost over it, and bury it either by sowing in rows or by a thorough harrowing. This method, which I have tried several times, produces very abundant crops, and brings the land into an admirable state of fertility, because it ensures the absolute decomposition of the turf, its transformation into humus, and gives it a more complete aeration than could be obtained in any other manner. But it is evident that this mode of proceeding must be more expensive than the others, and that it can only be adopted on small portions of land.

4. The fourth mode of proceeding is to burn the layer of turf. In my "English Agriculture," I have described this operation with regard to its application to soils which have produced grass for several years, and according to the manner in which it has been practised from the earliest ages in several countries.

But I must here speak of this practice with relation to its application to uncultivated land, and show in what manner it must be employed on them, less completely it is true, but also at less expense; and lay down some instructions as to the most economical mode of putting it in practice on soils of this description.

First of all, recourse is had to the operation described in a previous page under the designation of half ploughing, for the purpose of raising the furrow slices of the turf; that is to say, a slice is lifted up and turned over upon another by the side of it which has not been touched by the plough. This operation may be performed with any plough which has a broad sharp share, provided it be held in a somewhat inclined position, so that on the side on which the yet untouched earth is situated the share may enter rather more deeply, and on that next the mould-board the divided furrow-slice may be very thin, so much so, indeed, that the lower angle of the plough-share may merely graze the surface of the ground. The plough-share is made rather wider than usual, and very sharp, and its base formed with a more obtuse angle than would be given to it if it were intended for ordinary ploughing. The furrow-slice detached from the soil should not at most be more than two inches in thickness on the side next to the untouched earth, while it should be extremely thin on the opposite one.

When the soil thus prepared has remained for some time in this state, a strong harrow should be passed over it in a contrary direction to the ploughing, in order to tear in pieces and break up those slices raised by the plough: small harrows, having the teeth pointed and curved in front, may subsequently be made use of, to detach the roots and fibres of plants from the earth by which they are still surrounded. When the surface has, by these means, again become level, those strips of turf which were left untouched during the first operation must, in their turn, be raised and turned over in a similar manner, and subjected to the action of the large and small harrows. The ground is thus covered with the roots and fibres of the plants of which the turf was composed. In dry weather, for it will readily be conceived that such is the proper period for the performance of these operations, all these plants and their roots are collected, first into small, and subsequently into large heaps, for the purpose of being burned on the ground. A period is chosen for setting fire to these heaps when the weather is warm and there is a little wind: straw, peat, or dry leaves, are made use of for the purpose of producing ignition. It is highly essential that the burning should be so managed that the heaps may consume gradually and without flame. To effect this they are pressed down, and, when lighted, covered, as occasion seems to require, with earth. After they are totally consumed, the ashes are spread over the surface, and buried by ploughing the ground as superficially as possible. Any kind of produce required by the course of the rotation may then be sown. If, during the clearing of old forest land, a number of twigs and boughs should be left which cannot be made use of as fire-wood, and of which it is desirable to find some means of getting rid, they may be used to form the basis of the heaps which are to be consumed; and, by so doing, the burning will be accelerated and facilitated, and a greater quantity of ashes produced. The turf may, however, be completely consumed without the aid of any extraneous fuel.

Comparative experiments, conducted on the most extensive scale both in England and Scotland, have proved that burning is preferable to all other methods of clearing uncultivated lands, especially when they are of an argillaceous or marly nature.*

* This well known operation of agriculture, once much more extensively practised in this country than at present, consists in paring off the turf to a depth of two or three inches, generally by a breast-plough worked by a labourer, or by a turf-paring plough drawn by a horse; allowing it to dry, and then burning it in heaps. It is commonly best performed in the months of April and May. It is a practice now rarely adopted on sandy or calcareous soils; it is productive of good results on peat, and some kind of clay soil, but even there it is very doubtful whether it is the best mode of treating the land.

The practice is certainly as old as the days of Virgil, who mentions it in the first book of the Georgics. Endless have been the theories brought forward to account for its operation. Dr. Home thought it dispelled "a sour juice" from the land. ("Prin. of Agr.") Dr. Darwin thought it produced "a nitrous salt" in the ashes. "Many such obscure causes," says Davy, "have been referred to for the purpose of explaining the effects of paring and burning; but I believe they may be referred entirely to the diminution of the coherence and tenacity of clays, and to the destruction of inert and useless vegetable matter, and its conversion into a manure. All soils that contain too much dead vegetable fibre, and which consequently lose from one-third to one-half of their weight by incineration, and all such as contain their earthy constituents in an impalpable state of division, such as the stiff clays and marls, are improved by burning; but in coarse sands, or rich soils, containing a great mixture of the earths, and in all cases in which the texture is already sufficiently loose, or the organizable matter sufficiently soluble, the process of torrifaction cannot be useful. All pure silicious sands," adds Davy, "must be injured by it;" and here practice is found to accord with theory. Arthur Young found "burning injured sand;" and an intelligent farmer in Mount's Bay told me that he had pared and burned a small field, several years ago, which he had not been able to bring again into good condition. I examined the spot; the grass was very poor and scanty, and the soil a silliceous sand.

The process of paring and burning, therefore, seems to be most adapted for peaty or clay lands; for, as Davy continues, "The process of burning renders the soil less compact, less tenacious and retentive of moisture; and, when properly applied, may convert a matter that was stiff, damp, and in consequence cold, into one powdery, dry, and warm, and much more proper as a bed for vegetable life."

Davy examined three specimens of the ashes from different lands that had undergone paring and burning. "The great objection," he adds, "to this operation is that it destroys vegetable and animal matter, or the manure in the soil;

Frequently, when the surface of newly cleared land is uneven, it is necessary, in the first place, to smoothe and level it, in order to facilitate its cultivation and render its surface homogeneous, or, in other words, more uniform in quality. This operation is attended with great labour and expense, and locality can alone determine the most advantageous mode of conducting it. When the inequalities of the surface are very close together, they may, in general, be reduced by throwing the earth from the tops of the ridges or elevations into the hollows with spades or some other similar implement of manual labour. For this purpose, men are stationed at certain distances proportionate to their strength, and employed in throwing the earth which they have either raised or received from those next above

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but in cases in which the texture of its earthy ingredients is permanently improved, there is more than a compensation for this temporary disadvantage. And in some soils where there is an excess of inert vegetable matter, the destruction of it must be beneficial; and the carbonaceous matter remaining in the ashes may be more useful to the crop than the vegetable fibre from which it was produced."—(Agr. Chem. p. 344.)

Liebig thinks that all the benefit of burning the soil is attributable to its thus obtaining increased powers for the absorption of ammonia. He says, "Soils which contain oxides of iron and burned clay, must absorb ammonia, which is favoured by their porous condition; they further prevent the escape of the ammonia once absorbed by their chemical properties. The ammonia absorbed by the clay, or ferruginous oxides, is separated by every shower of rain, and conveyed in solution to the soil. Powdered charcoal possesses a similar action, but surpasses all other substances in the power which it possesses of condensing ammonia within its pores, particularly when it has been previously heated to redness. Charcoal absorbs ninety times its volume of ammoniacal gas, which may be again separated by simply moistening it with water."—(Organic Chem. p. 90.)

And it is evident, from the experiments which Liebig gives at p. 207, that charcoal powder is a very fertilising application to some plants. The practice, however, of paring and burning is evidently one whose advantages the farmer and the chemist admit with reluctance. And it is very probable that by other means, such as the use of lime, &c., most soils may be cultivated with more advantage to the farmer by the avoidance of this expensive and destructive process. "My practice," remarks Mr. Pearson, "in the use of turf for various purposes, convinces me that all lands must be injured by paring and burning, save those lands, which are few and far between, that possess too much inert vegetable matter; or, in other words, lands that grow their crops to such a state of luxuriance, as to prevent the desired intent of the cultivator. Those lands which possess too much inert vegetable matter might also be improved by having part of their subsoils burned; but not by burning the turf even here, for that is the only thing that can be commended on the spot that will cause fermentation in the soil when it is ploughed in."—(Quart. Jour. Agr., vol. x. p. 552.)—*Johnson's Farmer's Encyclopaedia.*

them, and thus passing it from the highest to the lowest portions of the land which is to be levelled. Should the distance be somewhat considerable, it will be necessary to make use of hand-barrows; if it becomes still more so, recourse must be had to waggons, or, what is still better, to dung carts with two wheels, or *shooting carts*.

In land which has been thus levelled, it too often happens that the elevated spots are deprived of the whole of their vegetable soil, which becomes accumulated in the bottom of the hollows; this evil is almost inevitable, and cannot be remedied without great labour and difficulty. Should it not be possible to avoid this defect by throwing back the higher stratum of the soil, it will be necessary to compensate the elevated portions by bestowing on them a larger quantity of manure and more careful tillage.

The removal of large stones often increases the difficulty of clearing an uncultivated soil to a considerable extent, and yet they must be removed at least as far below the surface of the soil as the plough penetrates in its course, otherwise it is wholly impossible to till the ground properly; should it be attempted without this preliminary preparation, a great deal of time will be lost in ploughing, and the work is sure to be badly and unevenly executed; besides, the implements made use of are very liable to be broken.

When such stones can be made use of in the construction of high roads, enclosures round the estate, or in the building of walls and houses, it is by no means uncommon for their value amply to compensate for the expenses incurred in extracting and removing them. If they cannot be used in this manner, the expense attending their extraction and removal may be diminished by sinking them in the ground to a depth at which they will not interfere with any of the operations of agriculture. For this purpose, a trench deeper than the stone itself is dug all round it, and it is laid in the hollow thus formed. The width and depth of this hollow must be greater than the breadth and depth of the stone, and its shape must be so contrived that the s tone when turned over may not present either of its angles or edges to the ground. It is said that stones which were once buried to a proper depth in the ground have subsequently been observed to make their appearance on the surface, and it has been found requisite to bury them anew. There is no doubt with regard to the fact, but it may be referred to a cause altogether different from the actual rising of the stone; the real state of the case is, that a portion of the earth by which the stone was originally covered may have been carried away by heavy rains or by the action of water; or the progress of cultivation may have insensibly spread this earth over a greater extent of surface; or lastly, and as is the case in my land, the stones may have been buried to such a depth only as would prevent their being reached when the land is superficially ploughed, as it used to be, but altogether insufficient for that purpose when the ploughing is carried to the depth to which I have lately carried it. It is, therefore, necessary to dig a much deeper trench for such stones than at first appears to be requisite; and the more so, as they may otherwise prove injurious to the fertility of the land in those places where they approach the surface.

If it should be deemed expedient to carry the stones off the land, it will be necessary to procure a cart adapted for that purpose, unless the carrying take place during the winter, when it can be performed by means of sledges.

Very large stones must be blasted, especially if they are to be made use of for the purpose of building. The most usual mode of conducting this operation consists in the use of gunpowder; but the execution of it should be entrusted to those only who have had experience in such matters, and who possess the proper instruments for the purpose. Many imprudent individuals have paid with their lives, or their health, the forfeit of their want of caution or skill in this operation; besides, the price of gunpowder causes it to be attended with no trifling expense. There is also another method of proceeding which possesses all the advantages of the last mentioned one without its disadvantages. This consists in heating the stone to a high degree, by means of a very fierce fire applied to one part of it only, and thus expanding it considerably. When the stone has been thus made intensely hot, water is poured upon it to make it crack, the effect being accelerated by powerful blows given with very heavy hammers; this latter expedient is not, however, absolutely necessary. A third method consists in piercing the stone in the direction of its veins, and introducing into the hole a cleft cylinder of iron, and then driving a wedge of the same metal in between the two halves of the cylinder. This mode of proceeding soon causes the stone to split; and although it takes longer time, and requires more labour than the others, it has a decided advantage over them in furnishing building stones of much greater beauty and with flatter surfaces. Finally, a quantity of water may, during the winter season, be introduced into a hole made in the stone to a sufficient depth; the aperture being then closed with some stopper closely driven into it. The water contained in this hole expanding as it freezes, exerts a force sufficient to break in pieces the strongest stones.

Quicklime thoroughly calcined is the most efficacious manure for newly cleared land, especially if the upper stratum of the soil contain a considerable quantity of undecomposed vegetable substances. On land of this description, it is scarcely possible to apply lime in too large quantities. Many agriculturists have found it highly advantageous to use as much as five winspel per acre, when the price has been moderate. If this substance is spread over the surface of the ground previously to the ploughing, and the tillage repeated several times during the summer, in order to effect a complete admixture of the lime with the soil, the former soon decomposes all the vegetable matters and converts them into very fertile humus. It likewise absorbs the acidity of the soil, and that tannin which is so injurious to vegetation; kills worms and insects, which sometimes multiply in land of this description to such an extent as totally to destroy

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the first crops sown upon it after it has been cleared. When newly cleared ground, rich in vegetable matter, has been thus manured, the most exhausting crops, even rape, may be grown upon it.

It must, however, be understood that lime is productive of but little effect upon a poor soil which contains only a small proportion of vegetable matter.

The soil of furze lands is not always sterile: its lower stratum often consists of a fertile clay, which amply repays the expense of clearing. Such soils also contain humus, but it is of a particular kind, and by no means favourable to the growth of anything but furze.

A year before the time appointed for breaking up a soil of this description, the furze should be set on fire during dry weather, after having previously been allowed to shoot up in all its luxuriance. In order to prevent the fire from extending beyond that portion of ground which is to be broken up and brought into cultivation, an event which might be attended with considerable danger and damage by extending the fire to neighbouring forests or plantations, care is taken to surround the space on which the furze is to be burned with a wide, shallow trench. The fire does not kill the furze; on the contrary, the plants put forth an abundance of new shoots on the following spring. These young sprouts of the furze are so grateful to sheep, that in some places the plant is set on fire solely for the purpose of obtaining them. The ground is then well stocked with sheep, care being taken to select for that purpose a breed which will accommodate themselves to, and thrive on, the young furze. During the ensuing winter the soil is broken up, and on the following summer ploughed two or three times; and, if possible, sheep are penned upon it. This mode of proceeding, and the manure resulting from the sheep-fold, is peculiarly well adapted for the purpose of decomposing the humus of furze, sheep dung containing a considerable quantity of ammonia.

Very little benefit is derived from the use of lime alone when applied to cleared furze land: the ashes of wood, and even of turf, are much more efficacious. Argillaceous marl combined with animal manure is productive of considerable effect upon such land.

On a clearing of this nature, it is best to begin by sowing buck-wheat; which, of all useful crops, is the one that accommodates itself best to such soils, and contributes most materially to change their nature. This kind of grain is often sown upon a second or third ploughing, without any further fallowing; it is very vigorous and luxuriant in its growth, especially when assisted with a little stable manure. It can be most advantageously used either as green meat or hay, and will thus become the means of producing the manure requisite for the amelioration of the newly cleared furze land. After buck-wheat, rye will usually be found to succeed best upon such soils; but after one crop of it has been grown, the land must be left for some years in a state of repose or pasturage, if we would increase instead of exhaust its fertility; and in order to lay the foundation of the pasturage, Dutch clover should be sown in the spring among the rye. Whenever attempts are made to obtain from land of this nature all the crops it is capable of yielding at once, it sinks into a more complete state of barrenness than that from which it was rescued by the operation of clearing.

To endeavour to clear and bring into cultivation a soil which consists entirely of sand, is a more hopeless undertaking than that of building upon the sands. There are but two cases in which such an operation can be performed with any degree of profit.

(*a*) When the land is situated in the neighbourhood of towns where it fetches such a high price when cultivated, that it is worth while to endeavour to form a new stratum of vegetable mould upon it, by carrying to it and mixing with it a quantity of clay, mortar, rubbish from old buildings, and other kinds of matters conducive to vegetation, which may be had in abundance in the adjacent town.

(*b*) Or when it is situated where adequate artificial irrigation may be given to the sand, so that the land may be converted into meadows, or appropriated to the production of useful vegetables. Where this cannot be done, it is often not only disadvantageous, but exceedingly dangerous, to turn up a dry sandy soil covered only with a light stratum of turf, and containing not more than five parts in a hundred of clay; especially when it is situated on an elevated spot, or in an open plain. It has not unfrequently happened that when a piece of land of this nature has been ploughed up for the sake of obtaining from it a few scanty crops, whole tracts of fertile fields have been laid waste by being smothered in a cloud of this sand raised by the wind.

Should it be deemed desirable to bring a less barren sandy soil into cultivation, the first and most important step to be taken is to surround and even intersect it with hedges, so that the wind may carry away less of its moisture, that effect which is designated "the chilling of the soil" prevented, and the vegetation protected. As sandy soils are incapable of maintaining anything like fertility, unless frequently suffered to lie fallow or converted into pasturage, at least so long as their nature remains unchanged, it is so much the more convenient to divide them into enclosures and protect them with hedges, as by this means it becomes easier to keep cattle on them, and the animals, when placed there, are more sheltered from the wind, a circumstance which tends greatly to their advantage. It is likewise of great importance that such tracts of sand should be protected from the north and north-east winds by plantations of lofty trees.

It is often absolutely necessary to fix and consolidate the surface of a sandy soil by forming a layer of turf upon it, no matter how poor its produce may be, for the sake of protecting the neighbouring fields from the devastations caused by the whirlwinds of sand. It is often exceedingly difficult to produce a growth of grass. Various species of plants which vegetate in sand have been proposed for the purpose, as sand Lyme grass (*elymus arenarius*), sand sedge (*carex arenaria*), couch-grass (*triticum repens*), creeping bent-grass (*agrostis stolonifera*). These plants, however, seldom become perfectly established on the soil until the land is protected by hedges, because the shifting of the sand, when constantly agitated by the wind, prevents the seeds from germinating, or at all events, hinders the germs from taking root in it, unless they have been sown during calm and damp weather.

When the sand is entirely naked and liable to be agitated by every breath of wind, the only means of avoiding the evils likely to ensue is to enclose it by means of hurdles placed at intervals, and in sufficient numbers to prevent the wind from acting upon or raising it. This kind of fence should not be placed at those spots where the motion of the sand is to be arrested, but where it begins to assume a moveable character. Indeed, it is useless to attempt to oppose any barrier to its progress, if the cloud advancing behind is not also stopped: whole forests and lofty trees have been known to be buried in this manner, even to the very summits of the highest boughs. But if the motion of the sand be first arrested on that side from which the wind begins to blow, and to lay hold of it, and that part protected from the force of the wind, then the attempt to put a stop to the accumulation has some chance of being attended with success.

These hurdles or fences are usually formed of the branches of the fir tree, and those are chosen for the purpose which still have their cones on, in order that the land may thus be planted with these trees, and they are placed at intervals of twenty or thirty paces apart. As soon as the motion of the sand is somewhat checked, hedges are planted extending from north to south, and their distance from one another is regulated by circumstances. If the sand is not very light, or the wind very impetuous, these hedges may be dispensed with, and the plantations of pine trees formed at once, so that the ground may be covered with trees and converted into forest land, which is by far the best mode of turning soils of this description to account. It would be useless to plant land of a sandy nature with fir trees without having previously taken the precautions above mentioned, unless indeed it had been covered with grass, in which case it may be successfully planted. A soil of this kind must not, therefore, by any means be completely broken up, if it is to be planted with trees: it should only be ploughed in alternate strips in the manner already described.

If a sandy soil is to be made to bear useful grasses, it must not be very light, but must contain at least eight parts in a hundred of clay. When such is the case, the grasses which will be found best adapted for the formation of the turf are sheep's fescue grass *(festuca ovina)*, red fescue grass *(festuca rubra)*, hard fescue grass *(festuca duriuscula)*, decumbent fescue grass *(festuca decumbens)*, sweet scented vernal grass *(anthoxatum odoratum)*, common cat's-tail grass *(phleum pratense)*, knot-stalked cat's-tail grass *(phleum arenarium)*, soft broom grass *(bromus mollis)*, barren broom grass *(bromus sterilis)*, soft holcus *(holcus mollis)*, meadow holcus *(holcus lanatus)*, meadow oat grass *(avena pratensis)*, cat's-tail canary grass *(philaris phleöides)*, and rye grass *(lolium perenne)*. Should the soil contain some slight portion of humus, there may be added to these, black medick or nonesuch *(medicago lupulina)*, bird's-foot trefoil *(lotus corniculatus)*, common bird's-foot *(ornithopus perpusillus)*, wild thyme *(thymus syrpillum)*, common marjoram *(origanum vulgare)*, common burnet *(poterium sanguisorba)*, and Dutch clover *(trefolium repens)*. If, at the end of a certain number of years, a stratum of turf of sufficient thickness has been formed, and the land has been used as pasturage for sheep, it may with certain precautions be made to yield two crops of corn; but the exhaustion which will result from such a course of proceeding must be compensated by manuring the land with dung. The first plants sown on it should be buck-wheat and spurrey, but they should be sown so late in the season that instead of ripening they may be killed by the frost and rot upon the ground.

Should there be a quantity of marl or argillaceous mould within a convenient distance of a soil composed entirely of sand, this latter may be permanently improved, and its nature to a certain extent changed by carrying to it a portion of this marl or mould.

The clearing of marshes is an operation of greater importance than that of sandy soils, and one which is not unfrequently productive of great benefit; but as the drying or drainage of such places constitutes the chief and most important part of such undertakings, I shall defer treating of this subject until we come to speak of draining generally, and the various matters relating to it.

In most cases great advantages result from lands being enclosed at the same time that they are cleared; and besides, hedges are often indispensably necessary for the protection of lands newly brought into cultivation. For this reason, therefore, I shall here state all that I have to observe with regard to fences, &c.

HEDGES, FENCES, AND ENCLOSURES.

Great diversity of opinion exists with respect to the comparative advantages and disadvantages of hedges around arable land. However zealous the advocates of hedges may be, there are, on the other hand, many agriculturists who, not satisfied with discouraging the formation of them, even go so far as to recommend the destruction of those already existing.

The following are some of the disadvantages which are attributed to hedges:—

1. They take up a great deal of room, and occupy ground, the loss of which is much to be regretted when the soil is of a good quality.

2. They prevent the land from drying, and, consequently, retard the seed time.

3. They cause the formation of large heaps of snow, which are a long time ere they melt and disperse, and thus they prevent the plough from being used at so early a period as it otherwise might. They likewise frequently overshadow and stifle those plants which grow near them.

4. They are complete nurseries for weeds. It is impossible to destroy the noxious plants which grow in

them, and, consequently, these latter extend their roots and propagate their seeds over the whole of the neighbouring ground.

5. They likewise afford refuge to insects, vermin, and various mischievous creatures, and especially to sparrows and mice.

6. They impede the cultivation of the fields, and especially the operations of the plough, by preventing it from being driven to the very edge of the land, and increasing the number of turns which it is compelled to make in ploughing a given space, which certainly is a manifest disadvantage.

7. They interrupt the communication between the fields, and often render it necessary to take a long circuit in order to get from one enclosure to another which is close by its side.

8. When they have ditches by their sides, the latter cannot always be made in the direction most favourable to drainage; so that the water flows back into them, swells over on to the land, interferes with the cultivation, and injures the crops. It is very seldom that enclosed land can be divided in such a manner as to admit of the ditches which surround it serving at the same time for the purpose of drainage.

On the other hand, the reasons about to be enumerated are advanced in favour of enclosures, and especially of quickset hedges:—

1. The experience of all ages has tended to prove that fields surrounded with hedges are always much more fertile than those which are left unenclosed. These fences are productive of beneficial effects in various ways, and especially as, by obstructing the course of the wind, they keep the land at a higher temperature. In the cultivation of gardens, the advantages of having the ground protected by hedges or walls from the power and effect of the wind, are generally recognised. It is a well-known fact, that plants growing in gardens are always inferior in vigour and beauty in those parts where the fence is broken. The column of air heated by the rays of the

sun during the day, protects the ground and the crops from the cold and chills of night. Besides, the lowest stratum of air contains the greatest quantity of those nutritious matters which are so essential to the support of plants; it is, therefore, advantageous to enclose this column, and prevent it as much as possible from being blown away by the action of the wind.

2. Whatever may be the use of fences in protecting vegetation, the favourable influence which they exert upon the health of cattle is still more evident and considerable. The more completely animals are sheltered from the wind, the better do they thrive while at pasturage. On this point, the experience and opinion of English agriculturists remove all shadow of doubt; and, consequently, a much higher rent is paid in England for pastures surrounded with hedges, than for those which are unenclosed, and the more so in proportion as the enclosures are of smaller dimensions; that is to say, in proportion as the number of fences is greater. According to some agriculturists, a field of fifty acres divided into five enclosures, will fatten as many cattle as sixty acres of land all in one piece.*

3. The preservation of moisture by means of fences is rather advantageous than injurious. Dry and elevated land is greatly improved by being enclosed; and it is for this reason that the value of a sandy soil becomes so much increased when enclosed and subdivided by good quickset hedges.

4. The portion of ground occupied by the hedges, and thus withdrawn from cultivation, is amply compensated by the wood which the hedges furnish, especially in countries where fuel is dear: the more fertile the soil, the greater is the quantity of wood which the hedges produce; and, at the same time, the smaller is the extent of forest land existing in the district, so that, were it not for the amount of wood derived from the hedges, there would be an absolute scarcity of fuel.

* And because while the cattle are feeding in one enclosure, the grass shoots up again undisturbed in the others, without being trampled upon by the feet of the animals, as it would be if the several spaces of ground were not separated by any enclosures.

The other disadvantages of which hedges and enclosures are said to be productive, are not of the slightest importance, and may easily be remedied, provided that care is taken to keep the fences in good condition, and prevent them from becoming infested with weeds.

From these contradictory opinions the following results must be deduced :—

1. A great number of hedges may be injurious to a soil which is naturally damp and moist, by preventing it from drying quickly. On land of this nature the hedges ought always to be removed, excepting in the neighbourhood of the ditches. While, on the other hand, hedges are exceedingly useful in dry situations, and on light sandy soils; and their utility in such places increases in proportion with their number. On land of this description, the advantages resulting from hedges greatly overbalances the defects with which, in some respects, they are chargeable.

2. If land be constantly kept in a state of cultivation and used as arable land, and sown every year, then the utility of hedges is not so great, and may even be counterbalanced by the impediments and loss of time which they occasion in the various operations of tillage, and especially in ploughing. But if the land be devoted, at alternate intervals to the pasturage of cattle, or converted into permanent artificial meadows, then the advantages of hedges preponderate over their disadvantages, because they greatly facilitate the keeping of cattle, and provide a beneficial protection for them. This last consideration is an inducement to choose that period for the cutting down of hedges in which the land is devoted to the first crop of corn, so that they may shoot up afresh by the time it is again converted into pasturage. In order that this may be effected, the course of the rotation must extend through several years, as ten or twelve for example.

The same considerations will determine the propriety of giving greater or less extent to the enclosures. If the soil be moist, and intended principally for the growth of corn, the enclosures should be tolerably large; but if, on the contrary, the land be dry, and intended chiefly for the maintenance of cattle, it will be found advantageous to divide it into smaller parts.

There are two principal kinds of fences—*dead fences* and *quick fences*, the latter of which are generally designated hedges.

Fences of the former class are attended with a disadvantage from which those appertaining to the latter are free, viz., that they gradually become deteriorated from the time of their erection; whereas, the latter, provided proper care and attention be bestowed upon them, become better and better every day.

The following are the dead fences in most common use:—

1. *Walls.*—This description of fence can only be used in those places where there is an abundance of stone adapted for the formation of it.

It is only around yards and gardens that walls are built with mortar; those which surround fields are seldom or never constructed in this manner.

We often see estates surrounded with dry walls, built entirely with the stones collected on the estate itself, or in the neighbourhood, and joined together with moss or turf. If we would have these walls at all durable, they must be partly composed of large flat stones, by means of which some degree of uniformity may be given to their external sides. If any stones can be found of sufficient size to pass through the whole thickness of the wall, the solidity of the latter will be increased: round stones may be used for the inside of the wall and for filling up the empty spaces. Should the number of flat stones be small, the wall must not be built very high: it may then be covered with turf, and gooseberry, or other bushes which grow very well in such situations, planted on it. The roots of these bushes penetrate into the earth which is placed between the stones, and, consequently, tend to increase the solidity of the wall; and what is of still more consequence, they likewise increase its height, and oppose an obstacle to the intrusion of men and animals.

Stones are sometimes used to form low walls or parapets, broad at the base, but narrow or rounded at the top. In these the stones are mixed with earth or turf, and covered with the same material: such bushes as will grow there are planted on the top to form a hedge.

The chief advantage of walls and fences of this description is, that they occupy but little space, and allow of the ground being ploughed up to their very bases. Even if they are not very durable, it is, at all events, easy to keep them up and repair them when the requisite materials are to be found on the spot. It is, therefore, exceedingly desirable that they should be erected in all places where, in order to give value to the land, it is necessary to clear the fields of stones, and where there is no means of making a better use of such stones.

Sometimes it is considered sufficient to mark out the boundaries of the fields by lines of stones sufficiently high to stop the teams; and occasionally a hedge is planted behind these border marks, for the purpose of protecting them. Sometimes, too, these stones are used to form a path for foot-passengers when the road is full of water, in order that they may not trample upon the ground in which the seed is sown.

Those walls of earth, either in a soft or hardened state, which are found in some countries, but which are more frequently used for the purpose of enclosing yards and gardens than arable land, last but a very short time and require frequent renewal. Sometimes it is not thought inconvenient to renew them, because the clay of which they are constructed acquires considerable fertility by being exposed to the influences of the atmosphere, and greatly enriches those soils on which it is placed, especially when these walls have been erected in villages, or in the neighbourood of dung-heaps, and the clay has consequently become impregnated with nutritious matters. But the clay used for this purpose must be procurable in the immediate vicinity; for the carriage of it from any considerable distance would be attended with an expense which, from the perishable nature of the walls, would soon become enormous.

Fences of dead wood. These fences are sometimes constructed by means of posts fixed in the ground, and thus made to form palings of various kinds. Pieces of split wood, the points of which are fastened to a cross piece either by nails or joints, or which are attached to one another by means of sticks woven among them like hurdles, form a kind of fence which consumes more wood than any other, and yet possesses but little durability. Posts driven into the ground to sustain rods or lathes extending from one to another, and fitting into holes or mortices made for the purpose, form a fence which is capable of preventing the egress of large cattle, but which will not keep in smaller animals, unless the cross pieces are very numerous and placed very closely together, in which case the posts will be considerably weakened by the closeness of the holes bored in them. On this account, some persons merely place the posts side by side, and connect them together with rough pieces or branches of wood.

I shall not enter into a description of the other varieties of lath fences, or of the more complicated forms of paling, because, on account of the expense of erecting them and keeping them in repair, they can scarcely be made use of excepting for the purpose of enclosing gardens; still less shall I stop to give an account of those which are made of boards joined or nailed to each other.

Fences are sometimes made of pieces of wood twisted together, where plenty of branches can be obtained. This forms a solid and durable fence, especially when the separate pieces which support it consist of wood which takes root and continues to vegetate for some time. Fences of this kind are constructed in various ways. All those formed of dry wood, though still often met with in various parts of Germany, will soon be proscribed, because the scarcity of wood, or, at all events the great economy which is introduced into the use of it, will not allow the continuance of such a practice. In villages, where fences of this sort are usually found, they have the great disadvantage of communicating fire from one cottage to another with almost incredible rapidity; so that when a fire breaks out, if these fences are not quickly pulled down, a whole village becomes in a few moments a prey to the devouring element.

Mounds, or ramparts, or banks of earth. These are usually defended on both sides by ditches, from which the earth of which they are formed was dug. They are usually covered with a hedge planted on the top; or, if the land be well drained, it may be planted on the sides or on the edges of the ditches.

The most solid banks of this description are formed of turfs placed one upon the other; and on sandy soils they can scarcely be made in any other way. But as it seldom happens that it is possible to obtain the turf for the formation of these banks from any extraneous source, it is necessary that land which is to be thus surrounded should not only be covered with a stratum of turf, but be continued in that state for several years, in order that the stratum may have acquired sufficient consistence for the purpose. This kind of fence is generally adopted where the object of enclosing land is to bring old pastures into cultivation and to prevent ingress.

These banks certainly take up a great deal of room; their breadth, including that of the ditches, amounting to sixteen or eighteen feet: the inner ditch may, however, be gradually diminished in breadth.

The following are the principal operations relating to the formation of these banks. The lines which determine their width are traced by means of a cord and a spade; the space usually allowed is eight feet. The space assigned to the ditches is marked out in a similar manner, the proper width for them at the top being four or five feet. The surface of the ground on which it is intended the bank should stand is then broken up, and the upper layer of the turf, for the space of about a square foot, removed to the depth occupied by the roots of the plants; and the mould which adheres loosely to it shaken off. About half a foot of turf is left undisturbed at the edge of the base of the bank; and upon this border, on both sides of the bank, the first row of turf slices is placed, the surface on which the grass grows being turned downwards; the pieces are laid perfectly level and close together, and somewhat, although very little, further back than the edge of the bank, so that they may begin the slope. The space between the two rows is filled up with earth taken from the ditches: care is taken to keep the earth within the space well pressed down, and in a level with the layer of turf. A second row of turfs is then placed on the first one, and the pieces composing the latter are carefully disposed so as to cover the joinings of the former; the arrangement of them being similar to that of tiles upon a roof. The second row, as well as the following ones, ought each to be a little way further back than the edge of the one which preceded it, in order that the slope may be regularly continued. The best mode of regulating this slope is to provide the workmen with gauges made of laths united together, and constructed in such a manner as to determine both the size and form of the bank. These may be placed at certain intervals, and lines stretched from one to another. When the height of the bank, measured from its base, is to be about three feet and a-half, the breadth of the ridge may be three feet; the slope of the sides being such as to reduce the eight feet of the base to this width of three feet at the summit. In arranging the turfs, care must be taken to place that edge which is most evenly cut outwards; this edge should likewise be cut in a direction parallel with the surface, so that it may naturally tend to form the slope. Where such is not the case, when the bank is finished all the irregularities must be cut away, so as to form an even surface. Each row of turfs should be carefully beaten down, and flattened on that which precedes it, but not so violently as to break it. It has already been observed that the space between the two rows must be filled up with earth and well beaten, so as always to form an even surface.

This operation is usually commenced in the autumn, and continued until the bank has attained the height of a foot and a-half or two feet: it is then left in that state during the whole winter, in order that the earth may have time to sink down and become compact. The operation is finished as early as possible in the following spring, before the weather becomes very dry, in order that the turf may have time to recommence vegetation. Those slices of turf which have been cut may, without incurring injury, be suffered to remain in that state during the whole of the winter; they must not, however, be piled one on the other, but spread over the ground in their natural position.

If the turfs cut from the bottom of the bank and the surface of the ditches be not sufficient to form the mound, a point about which no general rule can be laid down, since it depends on the greater or less thickness of the turfs, it will become necessary either to take up the surface of a large portion of the ground, or to obtain turfs from elsewhere. The latter course must likewise be resorted to, when banks are to be formed in places where grass does not grow. When the proper inclination is given to each side of the bank, the earth taken out of the ditches will be exactly sufficient to fill up the empty space between the turfs.

When the soil is very argillaceous, and possesses a considerable degree of tenacity, the use of turf in forming the bank may be dispensed with. In such a case it will be sufficient to cover the surface only with turf, after the bank has been formed of the earth taken from the ditches. Should the soil be naturally humid, this latter mode of proceeding is more to be depended on than any other, because the turfs obtained from such a soil being naturally spongy, and full of moisture and moss, soon decompose and fall to pieces when laid one upon the other. Where merely sufficient turf is required to form this covering, the quantity raised from the surface of the ditches will in general suffice; and, in this case, the grass bearing soil at the bottom of the bank need not be disturbed, but may at once be covered with the earth taken from the ditches, and the bank constructed of the form already described. But then greater care must be taken in cutting the turfs with which the bank is to be covered, and especially when they are thick. They must be cut in a direction oblique to their surface, so that, when placed upon the slope, they may fit into each other exactly, and the lower edge of each turf may adjust itself above the upper edge of that which lies below it. It will, of course, be understood, that this covering up of the bank must be commenced from the bottom; it is likewise necessary, not only that the first row of turfs should be of the same width throughout, but also that all the individual pieces of which it is composed should be of one uniform breadth. When this first row is finished, another is placed upon it, the turfs being adjusted to each other with all possible nicety, and so as to join evenly together, with the lower edge of one row slightly overlapping the upper edge of the one beneath it. Before the turfs are put on, the earth should be well beaten, so that it may present an even surface, and that no hollows may be formed in it.

A hedge should then be planted either on the top or at the side of the bank, and in a manner which we shall presently describe.

In moist situations, ditches without banks are preferable for the formation of enclosures: we shall treat more at large of the manner in which these should be formed when we come to consider the subject of drying and draining soils.

The planting of quickset hedges is effected in various ways; sometimes on raised banks, at others on level ground. These hedges are composed of various plants; sometimes of one species only, at others of several mingled together. The following are the plants generally selected for this purpose, and best adapted for it:—

White or hawthorn (*crategus oxyacantha*), dog or wild-rose (*rosa caninis*), hazel-nut tree (*corylus avillana*), elder tree (*sambuca nigra*), hornbeam (*carpinus betulus*), gooseberry bush (*ribes grossularia*), black-thorn (*prunus spinosa*), common birch (*betula alba*), narrow leaved English elm (*ulmus campestris*), willows and osiers (*salix*), acacia (*robinia pseudacacia*), brooms* (*genistæ*), common privet* (*ligustrum vulgare*).

The common barberry (*barberis vulgaris*) was formerly often used for this purpose, but its use is now quite abandoned; indeed, it has been discovered that this plant is very injurious to the corn growing in its neighbourhood, and that its pernicious influence will extend to a period of fifty paces.

Among this number of plants, care must be taken to select those which are best adapted to the nature of the land; the species which grow wild upon the soil are, undoubtedly, those which it is best capable of nourishing, and which may, therefore, with the greatest degree of probability be expected to thrive upon it. Nevertheless, when a soil is well prepared, plants with which it does not at first seem to agree, may often, by dint of care and culture, be made to grow upon it. Wherever there is any doubt with regard to the subject, it is prudent to mix such stranger plants with others which are indigenous to the soil, and may fill their places should they happen to fail.

Of all the plants used for the formation of hedges, *white-thorn* or *hawthorn* is the one best adapted to the purpose. It forms an almost impenetrable fence, grows very compactly, and does not throw out new ramifications from its roots into the surrounding soil; neither does it choke the plants in its vicinity, nor spread out its branches to any very great extent; and it may be managed so as seldom to require cutting, and then not to any great extent at a time: all animals avoid it on account of its thorns. It does not harbour birds or insects, and when once fairly fixed in the soil, allows but few weeds

* The author adds, that in the north of Germany that part of these plants which is above ground is often destroyed by the frost, but that they put forth fresh shoots.

to spring up around it. But it requires a good soil containing plenty of clay, or else garden mould; and will not thrive either where the ground is excessively dry, or where it contains any great quantity of moisture.

This plant is sometimes found growing spontaneously in copses, but such an occurrence is by no means usual; the artificial planting of it in nurseries possesses great advantages over any other means which can be resorted to for the purpose of obtaining it. Young hawthorns thus reared succeed much better than those taken out of forests, and which have consequently grown up in the shade; the same may indeed be observed with regard to all shrubs used in the formation of hedges. This circumstance should induce agriculturists to establish nurseries, from which they may obtain the plants required for the construction of their hedges. It is true that these nurseries require great care and attention, but where this can be devoted to them it will generally be found that the young plants reared there are not only much better, but cost less in the end than wild ones taken out of the woods would have done.

White-thorn is, of all shrubs, the one which there is the greatest difficulty in rearing; but in the end it well repays the care requisite to ensure its success.

The seed of this plant, which is enclosed in a red fruit, is gathered in the autumn, and immediately sown in rows in a good soil which is light and not too rich, or else it is placed in pots filled with good mould, and kept during the winter in a humid state and in a warm temperature. It is said that watering with pork-brine facilitates the germination of this seed.

When the seed of the hawthorn, after having been thus prepared, is put into the ground at the commencement of spring, it sometimes shoots up and forms young plants in the first year; whereas if this course of proceeding be not adopted, it does not spring up until the second, and sometimes even until the third year. In order to protect the seed when placed in the ground from the attacks of insects, mice, and other vermin, the earth surrounding it is mixed with broken glass, or other substances of a similar nature, and it is then covered lightly with earth. The nursery must be carefully kept clear of weeds; and, in order to effect this, the rows in which the seed is sown should be kept quite distinct, so that the space between them may be dug up with the spade.

In the second year after germination the young plants should be transplanted. The tap root must then be pruned, as well as those roots which extend in a horizontal direction, so that the young plants may put forth as much foliage as possible round their stems.*

The hawthorns are placed close together, but in rows sufficiently distant from each other to admit of their enjoying the influence of the sun and air. The more frequently the space between these rows is tilled and weeded, the better do the plants thrive. In gardens this cultivation should be performed with the spade or hand-hoe, but in large plantations in the open country it may be performed by means of a plough or horse-hoe. In the first year the implements of cultivation should be made to approach as near as possible to the rows, in order that the horizontal roots of the plants may be thus cut off; but in the second year the cultivation should not be brought so near them; finally, it is not judicious to heap the earth in any considerable quantities against the plants. The young hawthorns should be suffered to remain in the bed for three or four years, in order that they may attain the condition most favourable to their final transplantation.†

Some persons have advised that a poor soil should be selected for these nurseries, in order that the plants may

* I cannot believe that it is advantageous to cut away the tap root of bushes, the lateral roots of which ought not to spread out much.—FRENCH TRANS.

† In March, 1826, I caused a quantity of hawthorn seed to be sown in one of my nurseries at Mossa-lomborda, which seeds I had taken care to bring into a germinating state, by putting it in mould at the commencement of the autumn of 1825, and keeping it during the whole winter in a moist state, and at a high temperature. This sowing furnished me, in the autumn of 1826, or in that which followed the spring in which it took place, with 27,000 plants; all of which were transplanted to the places where they were required, either in that autumn or in the following spring, and succeeded perfectly well. Some of these plants had in the year 1829 attained a height of 1·33 metres.—FRENCH TRANS.

not become habituated to a great degree of fertility. Other agriculturists maintain an opposite opinion, and prefer plants which have acquired vigour from growing on good grounds.

When the time comes for transplanting the hawthorns to the place in which they are to form a hedge, the soil must be well prepared to receive them. If they are to be planted on a bank formed in the manner already described, their removal may be effected as soon as the bank is finished. The best of the soil, or that which is immediately over the turf and which becomes detached from it, should be preserved, in order that it may be placed at the top of the bank and piled round the roots of the plants. But if the hedge is to be planted on a flat surface, the best way is to dig up a strip of land about six feet wide and two feet deep. In places where the expense of such an operation would be too great to admit of its being executed on a large scale, it will be sufficient to till this strip of ground several times with a plough during the summer, carrying the first operation to the utmost possible depth; by this means the soil will be thoroughly loosened and cleared of weeds.

The little trench in which the young plants are to be placed must be opened before winter comes on; this trench is usually made about a foot in depth. The soil will thus become loosened and improved, partly by the effect of frost, partly by the influence which the atmosphere exerts upon it in the winter. The young trees should be planted as early as possible in the spring, even if a continuance of cold weather and frost is expected, and should be put in the ground immediately after their removal from the bed; but at this transplantation their roots should not be pruned, but merely a little cut off their branches. Care must be taken to place those plants which are possessed of equal vigour as much as possible together; while those which are more weakly should be left in the bed, or else planted together in one portion of the hedge, so that special care may be devoted to them. The practice of mixing strong and weakly plants together, though highly recommended by some authors, is undoubtedly a bad one, for it causes the weak plants to be impoverished and choked up by the stronger ones.

Should there be at hand a little black garden-mould or well prepared compost, it may, with great advantage to the plants, be put into the trench above the roots; and the poor soil taken from the bottom may then, without risk, be placed above the mould, to prevent the weeds whose germs are contained in the soil from springing up. The plants are placed in a row at intervals of from six to twelve inches. If they are vigorous and healthy they need not be placed nearer to each other than twelve inches. Sometimes two rows of hawthorns are planted for the sake of obtaining a very strong hedge, but in this case there must be a distance of at least two feet between the rows. Most cultivators plant the young hawthorns in an inclined position, and almost lying on the ground, so that they touch and cross one another. This is done with the view of making them grow in this oblique direction, and interlace spontaneously; but the result does not always correspond with the intention: the new shoots invariably grow in a direction nearer to the vertical than otherwise, and, what is more, the stems and branches rub against and injure one another. I have always found it much more advantageous to plant the hawthorn in the ordinary vertical direction; it is only the lateral shoots which can be made to interlace.

This interlacing of the branches is much accelerated by twisting the young shoots one over the other, and fastening them with rushes or small osiers; but this operation is a very troublesome one, and is therefore seldom practised, excepting in gardens or grounds of but small extent. It may, in fact, be altogether dispensed with, since the branches of hawthorn gradually become naturally interlaced, provided only that the hedge be properly attended to, and its growth not too much checked by the bushes being cut down close to the stem.

In order that the hedge may be well clothed with branches near the ground, it is advisable that within a year after the hawthorns have been removed to their place of destination, they should be cut down within two inches of the ground. They then throw out a proportionately greater number of lateral shoots from the stump, which shoots must be allowed to grow freely, and not too much shortened. When pruned with the knife or scissors, according to the method practised by gardeners, it is sufficient to cut away the shoots which rise in a too vertical direction, and suffer the lateral branches to grow. Not even for the sake of thickening the hedge at the bottom must the principal branches be cut down too low, or pruned too frequently, even when they have a tendency to rise straight up in the air; for when that is done, a new tuft of shoots is put forth, and a sort of crown formed at the place where these prunings have taken place, and the upper part of the bushes become too heavy in proportion to the stem; which disposition of the parts produces an effect precisely opposite to that which was intended, for the lower branches are thus weakened, and the bottom of the hedge becomes more and more naked. Hence, then, it is evident that during the first few years the top of the hawthorns should be only moderately pruned, and the lateral branches suffered to grow to their utmost extent. It afterwards becomes necessary to cut them, but this must not be done in the manner practised in gardens, the hedges of which are trained to form a sort of perpendicular wall, and are not so thick at the lower as at the upper part; on the contrary, the hedges of which we are speaking must be left as bushy as possible at the lower part, and that thickness gradually diminished towards the top. By a careful adherence to this plan, they may be made to retain their form, kept thick and well clothed to the very bottom, and rendered impenetrable. Subsequently, it will be sufficient to prune these hedges once in five or ten years; occasionally cutting away those shoots which grow too vigorously at the top, as may appear necessary. A hedge of this kind may be suffered to grow to the height of three feet and a-half without ceasing to be well clothed with leaves and branches; at that height it forms an excellent fence, and its goodness is increased in proportion as it is wider near the ground. A hedge of this description lasts a very long time; some may be found which have lived for upwards of a century, and are still in good condition.

Hedges of *black-thorn* and *dog-rose* are seldom formed by artificial planting; but, for the most part, grow naturally, springing up from the shoots which proceed in abundance from the roots of these plants. Shrubs of this kind may always be transplanted to any place, for they easily take root and are very hardy. They are seldom pruned, but allowed to grow freely; the only difficulty connected with them is to keep them within proper bounds, for they have a great tendency to extend themselves and take possession of the soil which surrounds them, by means of the numerous off-shoots which their roots send up. In the formation of hedges, these shrubs are seldom used by themselves, but mixed with various others.

Hazel-nut hedges are usually formed by sowing the nuts in rows, on the spot from which the plants they are intended to produce are required to grow. Such hedges thrive remarkably well upon newly formed banks, because the soil of such places is, in a measure, well tilled, and also because the turfs which they contain protect the plants from the effects of drought by their decomposition; and, moreover, when planted thus high, they are more out of the reach of weeds than when in the open fields. The land must first be prepared for the reception of these plants, as well as for that of hawthorns, by careful tillage with the spade or plough, and then the furrow formed in which the nuts are to be sown. This furrow should be made as early as possible, in order that the surrounding soil may have time to become aerated. In the autumn, the earth taken out of the furrow should be mixed with mud from the bottom of ditches, or dry leaves.

The nuts intended for sowing should be perfectly ripe. The best plan is to select for this purpose only such as fall spontaneously in the autumn, when the branches which bear them are shaken. These should be kept during the winter in dry sand. In the spring they must be placed in the furrow prepared for their reception, and sown in rows at intervals of four inches. I have found that it is injudicious to place them in the ground before the commencement of winter, because they then run a great risk of being eaten by mice. Generally speaking, the plants make their appearance in May, and by the end of the summer have attained a height of somewhat more than a foot. When they are too crowded, the alternate ones should be pulled up, and transplanted to places where there is room for them.

Hedges of hazel-nut trees only require attention during the first year of their growth; they must, for that period, be kept scrupulously clear of weeds. Subsequently, they should be cut down close to the ground every nine or ten years, and may by this means be made to furnish plenty of wood, which is of great use in cooperage, and they soon shoot up afresh with renewed vigour.

Hornbeam trees are reared in nurseries established for the purpose. This tree used to be in great request for the formation of hedges in gardens, and, indeed, when well pruned, it constitutes a very compact green fence; but without such treatment, the lower part of it soon becomes naked, and it has a tendency to shoot up to a great height; in this case, especially if it be planted in double rows, it forms a fence like one composed of stakes, and not a hedge, properly so called. The same may be observed with regard to the *narrow-leaved elm*, the *birch*, and the *elder* tree, unless their branches are occasionally lopped so as to make them put forth new shoots, or unless they are subjected to the treatment which we shall presently describe.

The rapid growth of the *acacia*, and the prickles with which its branches are armed, seem to render it peculiarly adapted for the formation of hedges; and many authors consider it to be well calculated for the purpose; nevertheless, I have never succeeded in forming a compact hedge with this tree. In fact, the acacia puts forth such vigorous shoots that they soon become woody, and cannot easily be restrained within the dimensions of a hedge. If, on the other hand, it be allowed to grow upwards, the lower part soon becomes bare, and thus the fence is spoiled. It is possible, however, that I may not have adopted the proper mode of managing it.

In hedges consisting of shrubs of various kinds, the acacia may produce a very good effect by means of its prickles: but these latter tend greatly to increase the difficulty of cutting and pruning the hedges, and bending and interlacing the branches in order to render the fence compact.

Hedges of prickly *broom* may easily be raised from the seed, by sowing it in the spot on which it is intended that the plants should grow; they form a tolerably compact fence, and possess but one bad quality, which is, that during severe winters they are almost invariably killed by frost.

Privet hedges do not form good fences.

The various species of *osiers* cannot be said to form a very compact hedge; nevertheless, a very useful kind of enclosure or fence, for the purpose of keeping cattle from straying, may be constructed of them. They are frequently employed with advantage for the purpose of protecting newly formed banks or mounds of earth from the attacks of cattle; and, for this purpose, are planted between the foot of the bank and the edge of the ditch; or else on the slope of the former, when it is intended that a hedge should be raised on its summit. In this case, osier twigs of about two years old are taken, cut into slips of from a foot to a foot and a-half in length, and planted, at intervals of two feet, so deeply in the ground as not to rise above three or four inches above the surface of the soil. After the first year these slips put forth shoots, which may be attached to each other. When the hedge on the top of the bank is sufficiently advanced in growth to no longer need defence, the osiers may be taken away.

In very dry places, the kind of osier best adapted for this purpose is the brittle osier; but in moist, damp situations, where there is no other means of forming a hedge, that species of osier should be chosen which is best adapted to the nature of the soil, and then the mode of proceeding just described had recourse to.

Fields are frequently enclosed with hedges formed of several of the different kinds of trees and shrubs of which we have just been speaking mixed together, and planted either on an even surface or on an embankment; but in these cases the hawthorn is seldom or never used. Sometimes the hedge is formed solely of oaks and beech trees, and it is then managed in the following manner, which the Germans call the *knick* method of proceeding.

When the trees of which the hedge is to be composed have taken root, they are cut down within a few inches of the surface of the ground, and nothing left standing but a stem of about four feet high, to serve as a stake. These are left at intervals of four feet apart. Should there be any space which cannot be filled up by one of these stakes, a branch of osier may be planted there. Great care must be taken to keep the row as even as possible, and about every twelve feet a tree must be left untouched. The ditches should then be formed, and the earth taken from the bottom of them thrown against the hedge. This must always be done whenever the ditches are cleaned out or repaired; for it would be highly injudicious to make any other use of such earth which belongs to the hedges, and serves to manure it.

When the trees which have been left unpruned have grown up, two notches are made in the stem; the first very near the ground, and the second higher up. These ought to be of such a depth as to leave only the bark and a little wood remaining on one side. This tree is then bent on the opposite side to that in which the notches were cut, and interlaced with or tied to the stakes of which we have before spoken. The trees thus trained continue to vegetate, and in time produce a strong compact hedge. This mode of proceeding is principally adopted with regard to hedges chiefly composed of hazel and birch trees. I have seen close compact hedges thus formed on the most sandy soils; but this practice is seldom adopted upon places and in situations more favourable to vegetation, because the rain water which drops from the places where the stems are tied or interlaced injures the young shoots and prevents the hedge from becoming covered with foliage.

On very fertile land it has often been found advisable to cut down hedges of this kind close to the ground every tenth or twelfth year, and then to suffer them to shoot up again at will. This practice is to be recommended not only because a larger quantity of wood is thus obtained, but also because, on land which is submitted to a rotation in which several years are devoted to pasturage, the hedges may be dispensed with during the period that the soil is tilled, and the crops thrive better when it is cut down.

If the farmer wishes to form a live hedge upon an even piece of ground, without ditches or embankment, it is absolutely necessary that it should be protected against the injuries liable to be done to it by cattle, as well as from those which may arise from the carelessness or wantonness of persons employed in or passing through the field, by a fence of some kind, which need not be constructed with more strength than is absolutely necessary to enable it to afford protection to the young hedge, until it is capable of taking care of itself. Whatever may be the nature of this temporary fence, it should be placed at some distance from the hedge; as, for instance, three, or even four feet; for if it were nearer, it would deprive the young shrubs or trees of the air and light absolutely indispensable to their vegetation; and when removed, that portion of the green hedge which had been shadowed by it would be so much affected by the suddenly increased amount of air and light thrown upon it, that the weaker plants would be liable to become diseased. If, on the other hand, the fence be too far off and too open, it does not protect the shoots of the young hedge from the attacks of cattle, and, consequently, the vegetation of the plants is retarded, and their growth stunted. Neither should a footpath be allowed to be established by the side of a young hedge, because the pressure of the feet of passengers, and the friction caused by their passage to and fro, is calculated to injure it materially, especially if it be composed of hawthorn.

The formation of enclosures and the judicious distribution of land, which may be effected by means of good and compact live hedges, contributes essentially to increase the value of property, by enabling the agriculturist to raise various kinds of products from it, and pasture various kinds of cattle on it at once. Robberies and damage occur less frequently on enclosed than they do on open fields. Besides, in my opinion, a province which is intersected with ditches and embankments of earth planted with compact edges, presents almost invincible obstacles to all hostile invasions, especially if it is properly defended by a well disciplined troop of light infantry. The enemy's cavalry and artillery would make little or no progress over it. The whole country would become a continuous fortress; and if, as might easily be managed, these ditches and embankments were constructed with some regard to military tactics, the country might thus be far better defended than it could be by means of fortifications; and it would be much less expense to government thus to make the whole country one uninterrupted fortress, than it now does to establish those fortifications around towns and villages which are so detrimental to the agricultural interest.

ON THE DRAINING OF LAND.

The ascertaining and adopting the best possible means of freeing land from prejudicial excess of moisture, may be ranked among the most important branches of agricultural science. The draining of land and rendering it healthy must precede all other improvements, as without in the first instance fully accomplishing this object, the farmer will find all his future exertions of little avail. A proper degree of drainage tends to protect the crops from the injuries which are liable to result from excess of moisture, and contributes materially to ensure their success. This operation alone has often been sufficient to render extensive sterile plains exceedingly fertile. But the art of draining is one of the most difficult and complicated of all those appertaining to agricultural science. It would be useless and impossible to attempt to point out all the different circumstances under which this operation has to be performed, and the modifications which must be introduced into it, since each one has its own peculiarities, and requires to be treated accordingly. It will be sufficient if we endeavour to give our readers a clear notion of the laws by which the motion of water is governed, and the manner in which it affects solid bodies; or, in a word, the various causes which tend to produce excessive humidity, that my readers may be enabled to distinguish them at a glance, and determine at once, in each particular case, the cause by which it is produced. This being ascertained, the most efficacious means of remedying the evil, and those best adapted to the situation and locality, will present themselves. It may be supposed that any remarks on this subject ought to be prefaced by a dissertation on the theory of hydraulics, hydrostatics, and the mathematical principles on which this portion of the sciences depends. But as it is simply my intention to enter into such considerations as every agriculturist may be supposed to be acquainted with, I shall content myself with describing what may be understood and performed without reference to these branches of science; or, in other words, those operations which come within the sphere of action of every practical agriculturist; and under this class, the drainage of extensive plains, the means of protecting them from excess of moisture by large dykes or conduits, and the formation of canals, &c., cannot be comprehended. Undertakings like these come within the province, and ought to be confided only to skilful engineers, who have made such matters their principal study; and even such men are frequently liable to commit errors, and show by their manner of proceeding that there is much regarding this branch of science yet to be learned.

It is a well-known fact, that water, by reason of the want of adherence between its parts—a circumstance which constitutes its fluidity—has a tendency to occupy with each of its molecules the lowest spot which it can find; and thus to seek a level, or form an horizontal surface. This fluid does not act merely on its base with a power proportionate to its weight, but its action likewise extends to the sides: its pressure is prolonged so long as the adherence of its particles remains unbroken. This accounts for the fact that when water is introduced into two tubes, the inferior extremities of which communicate with each other, its water assumes a horizontal position; that is to say, it rises to an equal height in each tube, or, in other words, finds a level. An alteration of the dimensions of the tubes will not prevent this. Even when one is larger than the other, the water rises to the same height in each; because, in general, the atmospheric pressure is not at all impeded by friction. But when one of the tubes is very much smaller than the other, the water will rise higher in it than in the larger one which is united to it, on account of the force of attraction which solid bodies exercise on fluids, according to the well-known laws of capillary attraction. Loose earth acts in the same manner as the capillary tubes. In order to become convinced of this fact, it is only necessary to place a pot full of earth, in the bottom of which several holes have been bored, in a vessel containing water, and it will soon become apparent that the water has arisen in the earth to an elevation considerably above the level of the water.

Soils are generally formed of layers of earth and of stone, some of which are porous, and permit the water to pass through and unite with them; while others are impermeable. Mould, turf, sand, gravel, pulverulent lime or chalk, all stones having a porous tissue, schists and rocks containing fissures, are permeable bodies;

while dense rocks, various kinds of fossils, tenacious clay, &c., are impermeable bodies, which oppose an obstacle to the passage of water, and retain it. When these latter become indurated and compact, and are saturated with water on their surface, they do not suffer it to percolate or escape, but resist it the same as metal or hard wood. Mixed soils absorb and allow the passage of water in proportion to their combinations and their degree of porosity. All the fluid which we find on the surface of the soil is occasioned by these alternating and interrupted strata, by those various stratifications, and the furrows and canals which penetrate our soil to unknown depths. If the permeable layers were uninterrupted, the water would gradually sink nearer and nearer to the centre of the globe; and thus rivers and even the sea itself would finally disappear. If, on the other hand, the whole surface of our earth were formed of one uniform impermeable layer, all moisture would flow to the sea directly it had fallen from the atmosphere, and there would be neither springs, rivers, or fountains. But impermeable strata are intermingled with others that are permeable, in the same way that the human body is intersected with veins. There are but few places where water may not be found, although it frequently exists at a great depth below the surface.

In permeable bodies the water penetrates as deeply, and extends itself at the sides as far as possible; that is to say, until it encounters some impermeable stratum which impedes its progress. Thus, a permeable soil which rests upon an impermeable layer, and is surrounded on all sides to a certain height by a stratum which will not admit the passage of moisture, must inevitably form a reservoir of water, and have all its pores thoroughly saturated with that fluid: it continues to absorb water until this is the case, and then the fluid regurgitates back to the surface, renders the adjacent land moist; and in wet seasons, when a larger quantity of rain falls than the reservoir is capable of containing in addition to the moisture already assembled there, it necessarily overflows and the water spreads itself over the surrounding land. If the boundaries of this porous earth are of an equal height all round, and the bottom perfectly horizontal, the superabundant moisture rises equally on all sides; but as this is seldom the case, it generally runs off on that side on which the boundaries are lowest. Sometimes the outlet through which it passes is very narrow, and may be compared to a small piece broken out of a basin, or to the opening through which a brook emanates from a lake. By means of this outlet, the reservoir throws off its superabundant moisture; at least, so long as the quantity of fluid produced by rain or other causes, and the continuous amount of pressure, be not so great as to render it insufficient for the purpose; whenever the latter is the case, the water rises much higher than it would otherwise do, and floods all the lower ground in its neighbourhood.

The result is always the same whether these reservoirs exist on the surface of the soil and present themselves to our view under the form of ponds, lakes, &c., or whether they are situated at a greater depth, and covered by a tolerably thick layer of earth. It is likewise immaterial whether they or their openings are formed by empty spaces containing nothing but water, or are filled with earth and porous stones which receive the fluid into their pores and clefts, and suffer it to pass through. The only difference is that the latter imbibe a smaller quantity of water, and do not suffer it to flow so freely, and that this water does not become mingled with anything, but merely occupies the vacant space. The effect of pressure, however, and the addition from above of more moisture, will eventually of necessity cause the reservoir to overflow. Thus, when a reservoir situated in an elevated position communicates with one lower down by means of an open passage, or, what amounts to the same, by means of a layer of permeable earth, the latter will receive the pressure and the superabundant moisture of the former until such time as the water in both forms a level, or, in other words, a horizontal line similar to that which it takes up in two tubes placed vertically, the lower ends of which communicate with one another.

Although these facts are universally known, I deem it right to recapitulate them here in order to be able to make myself understood in the succeeding paragraphs without running the risk of being too prolix.

I must now go on to speak of those considerations and precautions by which we must be governed in all our endeavours to drain land and free it from its superabundant moisture.

The first thing to be done is to find a level, that is to say, to ascertain the height of the point at which that water which we wish to get rid of is situated; also, that of the place to which we would convey it, and of all the intermediate points through which it must pass. The art of levelling and the use of the draining auger will be found applicable to this operation.

Drains, ditches, or gutters, are usually formed for the express purpose of carrying off any superabundance of moisture which may exist in the land.

These may be divided into two classes, according to the purpose for which they are formed:—

1. Drains, ditches, or gutters, to collect water.

2. Gutters or trenches which are intended for the purpose of draining land, and rendering it healthy by freeing it from moisture.

The former, by means of which the water is collected which flows from elevated spots, and prevented from overflowing the plains beneath, ought to intersect the declivity of land. In general, they should be perfectly horizontal at their base, and should have what is called a dead level. It is, however, necessary that the horizontal line which forms the bottom of the ditch should be a little deeper than the layer of earth on which the moisture which we wish to carry off rests or flows.

Drains or gutters for the purpose of carrying off water, whether intended at once to get rid of the moisture which rises in the ground, or as canals to carry off the water collected by ditches of the first class, ought to receive an inclination towards the bottom of the declivity, and to have some slope. But in the greater number of cases this slope must be very gradual, an inch in twenty perches is admitted to be the general average. It is often imperatively necessary to avoid giving a greater degree of inclination to them, lest the bottom should be injured by the too rapid course of the water; and it is sometimes even necessary that their length should be increased, in order that the slope may be rendered more gentle.

When such a drain or gutter is to be dug, the first thing to be determined is its depth, and the width of the lowest part of it, or that on which the water rests. The depth below the surface of the soil to which it is to be hollowed must be determined in different places by levelling, and its breadth be made proportionate to the quantity of water which may be expected to pass through it. As these ditches must sometimes be horizontal, and at others receive a gentle slope, according as the surface through which they have to pass rises or inclines, they are made deeper or more shallow according to the undulations of the soil. The width of the top of the ditch must be regulated by that of its base, and by its depth, in order that the sides may always have a proper talus. When the land is of a firm and solid nature, the following is the proportion usually adopted: the summit or top of the ditch is made half as wide again, in proportion to its height, at the bottom. Thus, if it is three feet deep, and two feet wide at the bottom, it ought to measure $3 + 3 + 2 = 8$ at the top. If the surface through which it passes rises a foot, the width of the top of the ditch must be increased to ten feet, and if it rises two feet to twelve feet, in order that the sides may maintain an uniform degree of inclination or slope, and form with the base an obtuse angle of one hundred and thirty-five degrees. In sandy or marly soils, which possess but little solidity and adherence, this inclination is frequently not sufficient, and the top of the ditch has to be made one-half or one-third wider; it is not uncommon for it to be necessary to give a perfectly rounded form to drains or ditches, the profile of which is similar to that of an inverted bow, and in this case grass is suffered to grow on them, so that they furnish fodder for cattle.

The digging and forming of these ditches or gutters is usually performed as task work, and the price regulated by the cubic measure of earth removed; but the operation is rendered more or less difficult by the nature of the soil on which it has to be performed. When the ground is light and sandy, the digging up of a surface of one hundred and forty-four Rhenish feet to the depth of a foot will not generally cost more than three groschen; but if the soil is very argillaceous and tenacious, the expense will be increased to double that sum: on average soils it will be proportionate to the degree of their tenacity. The expense of the operation depends, however, in a great measure on the depth to which it has to be carried; for, as the extraction of the earth becomes more and more difficult in proportion to the depth from which it has to be raised, so must the wages of the workmen be increased in exact ratio with the depth to which they have to dig, otherwise they will gain nothing by the job.

While digging these ditches, it is highly requisite that care should be taken to throw the earth sufficiently far, not only to prevent it from bearing an undue degree of pressure on the edges, but likewise to prevent it from being in the way, and having to be removed again should it be necessary, as it frequently is, to enlarge and widen the drain.

I must here observe, that it is not sufficient to trace out and dig a ditch or gutter, but it must also be kept clear and in good repair; consequently, in forming an estimate of the expenses attending it, those of keeping it in order as well as establishing it must be calculated; and these will be found to vary in different localities, and under different circumstances.

I shall proceed to speak of aqueducts and subterraneous drains by and bye. Previously to undertaking any operations for the purpose of freeing a soil from its superabundant humidity, we must, in the first place, endeavour to ascertain precisely from what cause this humidity arises, in order to be enabled at once to adopt the most efficacious means of remedying the evil, and those best adapted to the locality.

The causes generally productive of superabundant moisture may be classed under the four following heads; or, in other words, the evil may arise—

(*a*) From rain water or other moisture deposited by the atmosphere on a spot where, from the retentive nature of the materials of which the surface is composed and the strata on which it rests, this fluid cannot penetrate deeper or flow onwards.

(*b*) From water which flows from higher grounds, and which is retained on the surface of the soil by inequalities or elevations, which force it to remain in that place until it evaporates.

(*c*) From water which flows from elevated regions, and descends for a considerable distance among the porous substances between the different strata of clay before it shows itself, or breaks out on the surface of the ground, beneath which it often forms actual springs which have no means of escaping.

(*d*) From water-courses, which occasionally or permanently cover the surrounding land with water, either by overflowing it, or gradually trickling over and saturating it; or which, by the elevation of their bed and of their general surface, prevent that moisture which descends from the heights, and is collected on the plains, from draining away and escaping.

(*a*) The moisture which falls immediately from the atmosphere becomes injurious when deposited in too large quantities or in places whence it cannot escape.

If the layer of vegetable earth is composed of clay or lime, or is of a highly tenacious nature, its surface only is ploughed; and that very superficially, on account of the difficulty which there is in tilling soils of this nature. The under layer thus becomes formed into a hard crust, which retains all that exists beneath it, and prevents the passage of any from above; consequently, the surface becomes thoroughly saturated, and during heavy rains, or excess of moisture from any other cause, is transformed into a paste, in which state it is exceedingly injurious to plants, and speedily causes their roots to rot, and themselves, consequently, to perish.

These are not the cases in which under or covered drains are likely to prove beneficial, for as these latter are covered over with earth at least nine or ten inches thick, the water cannot penetrate through this hard layer into them. Wherever proper attention has not been paid to this point, under drains have been found altogether useless; or, at any rate, their utility has lasted but for a very short period; for the earth with which they were covered, although loose and porous at first, is not long in becoming hardened, indurated, and forming an impermeable mass above them.

In order to insure to a field those advantages which subterraneous or under drains are capable of communicating, it must, previously to their formation, be ploughed deeply, and several ameliorations of dung bestowed upon it, in order thoroughly to loosen the soil and render it permeable at least to a depth equal to that which is to cover the drains.

In most cases, open drains or gutters are in general preferable to subterranean ones. Sometimes recourse is had to these open trenches for the purpose of draining an even soil, and then they are made in that direction in which the declivity of the land is most perceptible; or, in other words, in that which is most likely to carry off the water soonest and best. At other times, the land is divided into beds, slightly raised, elevated, and separated from one another by deep furrows for the purpose of carrying off the water, which latter are carefully kept clear and open. Besides this, when occasion requires it, these furrows are connected with transverse drains, which intersect the beds or ridges, prevent the water from stagnating, and carry it off to ditches, brooks, or ponds, where it can do no harm. When the fields are left flat, it is highly important that the drainage furrows should receive such a distribution, direction, and slope, as will best render them useful. It is by no means beneficial to make too many of them: first, because more labour will be thus occasioned; secondly, because they would occupy too much space; and thirdly, because when they do not contain water enough to enable it fully to clear its way, they are injurious rather than beneficial; and lastly, because they create inequalities in the soil. When these drains or gutters proceed from low ground, and have to be carried across elevated spots, they produce an effect diametrically opposite to that which is expected of them, and only serve as conduits to convey stagnant water back to the very places they were intended to drain. In such cases as these, the best way is to dig a trench about the elevated places which surround the low land, and thus intercept that moisture which would otherwise run down on to the latter, and carry it off before it proceeds beyond its proper limits. Too sudden and abrupt a declivity is as much to be avoided as a want of sufficient slope; because, in the former case, when heavy rains fall, the water is apt to rush down with such rapidity as to carry away the soil with it, and thus create embankments at the foot of the hill. Under circumstances of this nature, a circuitous direction should be given to the drains, in order to render the slope more gentle, and suffer the water to drain away without doing any mischief. In general, in proportion as there is difficulty in draining a field, and as its tillage requires tact, skill, and science, in like proportion do we find absurd and ill-conducted operations. Many agriculturists think to shew their skill and industry by intersecting their land in every direction with drains or gutters, for the purpose of carrying off moisture, until it almost resembles the model of a seat of war, surrounded by numerous fortifications in a state of progress; but this excess of drainage is not only useless, but is productive of serious evils.

A plough is frequently made use of for the purpose of forming these furrows or drains; and one having two mould-boards is usually selected for the purpose, which, as it completes the furrow at once, admits of one being made as it passes up the field and another as it returns. There are ploughs constructed expressly for this purpose. The foremost part of the share of these instruments is made in the form of a wedge, while the hinder part has a quadrangular shape; they are provided with two raised mould-boards, one on each side. These ploughs form a rectangular furrow, and the two mould-boards raise the earth extracted from beneath, and spread it on the edges at either side, so that it shall not fall back again into the furrow. But when it becomes necessary to make the drainage furrows of some considerable depth, these implements encounter great resistance, require great draught power; and as the bottom of the furrow which they trace is always parallel with the surface of the soil, they become useless when they have to traverse an undulating or rugged surface, because the course of the water would be impeded if the elevations left by the plough in the furrow were not got rid of with a spade. Our plough, with two moveable mould-boards, is best adapted for the purpose of forming these drains. This instrument is more manageable, and can be made to penetrate deeper into the soil, at will. At first, the mould-boards are only opened a little way, but subsequently, when the plough is introduced into the soil a second time, at those places where elevations of the ground exist, the instrument is made to penetrate further, in order that by a uniform slope being given to the bottom of the drainage furrow, the water may be properly carried off. This instrument forms an angular furrow at the bottom; while its sides, having a due degree of inclination given to them at first, seldom require to be touched by the spade. No time must, however, be lost in levelling the earth thrown up by the mould-board on the edges of the furrow, especially if the furrow has been formed subsequently to the sowings, otherwise there will be danger of the seed being smothered under these heaps of earth. This operation can easily be performed by means of a rake.

Many agriculturists prefer having these furrows formed by spade labour.

In whatever manner they may be made, they must be carefully attended to, and occasionally repaired and cleaned out, especially at those periods when heavy falls of snow melt, because it is impossible to foresee the causes which may tend to obstruct, choke, or fill them with sand.

It cannot, however, be denied, that too great a number of these drains or gutters are apt to leave slight inequalities in the land which can never be entirely got rid of. When the soil is of a tenacious nature, these inequalities are injurious, and in some places even tend to impede the operation of sowing. This consideration leads me to give the preference to the formation of large and slightly elevated beds and ridges on flat even soils which possess but little slope, particularly if such a direction can be given to these ridges as will cause the water to drain off easily through the furrows or trenches by which they are separated. But I should not advise that, on a width of from two to three perches, the centre of these ridges should be raised more than six or eight inches higher than the sides of the trenches. Great care must be taken to prevent the earth from being heaped up at the sides; and in ploughing the ridges, the curve or elevation must be extended in an almost insensible manner over the whole of the ridge. As in this case the trenches will always be formed in the same spot, especially when the ground is prepared for autumnal corn, their direction must be carefully determined so that it may accord with the declivity; and all things so arranged that no hollow shall remain on the ridges; at any rate, none below the level of the trenches. The latter must be carefully finished off, and always kept clear and open, so that the water may pass freely through them. They should be brought into communication with each other by means of cross open drains. But in order to render these drains perfectly efficient, a canal or ditch for the reception of the water which they collect, and towards which they should all slope, is absolutely requisite at the bottom of the enclosure. Where this advantage is unattainable, a ditch or main drain must be dug in the lowest and dampest part of the field, for the reception of the water, and thus a portion of the ground sacrificed in order to save the rest.

It very often happens, that although the layer of vegetable mould is sufficiently loose and porous readily to allow moisture to sink into and filtrate through it, there is beneath it an impermeable retentive layer of clay, which prevents the water from passing. When the layer of vegetable earth is thick, it is better capable of bearing heavy rains, because there is then more room for the water, and, consequently, it does not flow back to the surface so soon; but when the quantity of water becomes so great as to render it impossible for it to be contained in the interstices of the soil which constitutes the vegetable layer, the land suffers from excess of moisture for a considerable period. This superabundance of humidity is longer in evaporating in proportion to the thickness of the layer of earth which is saturated with it.

We spoke of the means of deepening the layer of vegetable soil while treating of the subject of ploughing.

The thicker this cultivated layer of the soil, the deeper must be the drains or furrows made for the purpose of carrying off the humidity; for in order that they may produce the desired effect, they must be hollowed out to the impermeable layer. If care has not been taken to make them sufficiently deep to reach this level, the water, instead of being carried off, sinks through the permeable earth at the bottom; therefore, even though constructed in the direction of the declivity, they will be productive of little or no effect, since at most they would only carry off the overflowings of the water, while the remainder will sink into the permeable soil beneath, and render the bottom of the soil prejudicially wet.

These trenches must, therefore, be horizontal, and intersect the declivity, in order to cut off the water and conduct it into the drain which is to carry it off. Should the sides and bottom of them not be made sufficiently compact to prevent the water from filtering through, it will penetrate into the soil, and, according to the laws of gravity, extend itself over a fresh portion of the field until taken up by some other drain or furrow.

Such deep trenches are attended with great inconveniences. They are destroyed by each ploughing; and, consequently, when the land can only be preserved from excessive humidity by their means, require to be as often reconstructed. It must be confessed that this is seldom done on account of the labour that would be thereby entailed, and the great expense arising from the performance of the operation, and from that of spreading over the ground the quantity of earth which has been thrown up while forming the trench. Besides, there will always remain perceptible hollows in those places where the drains previously existed; and if the new ones are not traced exactly in the same spot occupied by the others, these hollows will become receptacles for standing water, which will essentially injure the crops. This will invariably occur after the melting of heavy falls of snow. When the snow melts rapidly, or heavy storms of rain fall, whatever care may have been bestowed on the formation of these deep drainage furrows, the water will frequently overflow and carry away with it portions of the surrounding soil; therefore, in cases where drains are absolutely indispensable, it will be best to form subterranean or covered drains; and it not unfrequently happens, that the expense attendant on their formation are amply repaid in the course of one or two years after their construction in a cold wet soil. If these drains are properly arranged, the field may be left perfectly flat, and ploughed alternately in all directions, and at almost all times and seasons, without suffering from excess of humidity.

There are two points which must be attended to in the making of under drains. If the land has any degree of declivity, they must, in order to be productive of the required effect, be made in a contrary direction to it, and intersect or cross the slope, otherwise they will not be able to collect all the water which is contained in the soil. When formed in this transverse direction, a slight degree of inclination towards the ditch which is to receive and carry off the water, must be given to them; but this must never go beyond an inch in ten perches. It is, of course, understood, that it must be guided by the horizontal basis of the soil, and not by the surface, which is often unequal.

The best way of managing these subterraneous drains, is to make them open into a ditch or conducting drain which is to carry off the water to some river or lake, and to surround the opening with stones to prevent it from falling in or breaking. Sometimes, two, three, or more drains are made to meet together, and emit their contents through one opening; but this is a mode of proceeding by no means to be recommended, because one or the other will very frequently be choked up, and it will then be difficult to discover which one is at fault.

These drains or gutters are made of various depth. If an impermeable stratum is found existing beneath a layer of porous earth, it is necessary to dig on until we come to the latter, and there form the canal along which the water is intended to pass. If, on the other hand, the layer of argillaceous earth is not very thick, it will be sufficient for the drain to be covered by a foot of earth, or even by ten inches, when the soil at the surface is moderately tenacious; but in cases of this nature the ploughings must never be carried beyond a depth of six inches. In light loose sandy soils, the drains must be covered with at least eighteen, if not twenty-four inches of earth. This thickness is, however, subject to modification. If the drain has to be carried through a rising ground, a depth of from nine to ten inches is sufficient for that portion of it which is intended to contain the water. It may be made as wide, or a little wider than it is deep; but this will depend, in a great measure, on the nature of the materials with which it is to be filled up. If rough stones gathered from the fields are to be made use of for the purpose, its width at the top should be sixteen, and at the bottom only ten inches; but when it is to be filled up with branches, nine inches will suffice for the width at top, and two or three at bottom.

In digging drains, their opening at the surface of the soil should be made large enough to enable every part of the operation to be conveniently carried on.

In large undertakings, it is customary to make use of a plough for the purpose of commencing the opening of a drain. Two furrow slices are thrown off by this instrument, the one to the right and the other to the left, and a strip of earth of about fifteen inches wide left between the furrows. This strip is subsequently divided with a strong plough, having a double mould-board. The first time this instrument passes through the soil, it is made to penetrate to the depth of about a foot; and the second time it is so arranged as to turn up the soil to at least six or eight inches lower down. The earth is immediately removed from the sides, lest it should fall back again into the ditch during the operation. The excavation is then continued with manual implements. A common spade is first made use of which is a little narrower at the bottom than it is at the top; and, subsequently, another is had recourse to, the upper part of which is scarcely so wide as the lower part of the former one, and its extremity not more than three inches wide. By digging successively with these two instruments, and exercising a little care and skill, the drain will speedily become properly shaped; the walls must then be united, and all the loose earth which has fallen to the bottom removed thence with a curved shovel. That part of the drain through which the water is to pass, must then be lined with stones or with branches, according as one or the other can be procured with the least trouble and expense. If the stones can be obtained from a neighbouring field, they are to be preferred. The large and small ones are mixed together; but in placing them in the drain, care must be taken to pile the largest and flattest along the sides. When branches are made use of, they are sometimes tied up in bundles; but it is much better to lay them in one by one, the largest being placed at the bottom, and the smaller ones above.

Experience has proved that light, aquatic wood is better adapted for this purpose, and more durable than hard wood; thus the branches of alders, willows, and poplars, are preferable to those of firs, the juniper, and other resinous trees. It is, however, highly essential that the branches made use of shall have been fresh cut, or, in other words, green and full of sap.

It is generally found that drains lined with branches remain open longer and are more durable than those in which stones have been made use of; even after the wood has rotted, the drain retains its form if the soil be of an argillaceous nature.

The stones or branches with which the drain is filled must be covered up with straw, furze, rushes, or similar material, in order to prevent the earth from sinking in between the interstices; or they may be simply covered with the turfs raised from the surface of the ditch, turned bottom upwards, and pressed down with the feet to render them solid.

When the trench comes to be covered up, care must be taken neither to put very loose earth above it, which might sink in and fill up the interstices through which it is intended the water should pass, nor yet tenacious clay, which would soon adhere so firmly together as altogether to prevent the filtration of water through it. The soil immediately over the trench ought to be left a little higher than any of the other parts, because it invariably sinks down and diminishes.

When the soil is of a highly argillaceous nature the drains are seldom made very wide, and are filled up with straw twisted into the form of ropes; sometimes they are left empty and simply covered with turfs: the clay soon gets so firm and hard that a crust is formed all round the drain, and the lower part remains open long after the straw has rotted away.

In some places, instruments termed mole-ploughs are introduced into the soil, the effect produced by which is highly satisfactory.

In loose, sandy, and peaty soils, bricks made for the express purpose, and other inventions of art, are employed in sustaining the walls of drains, and sometimes the gutters are left entirely open.* Trenches for the purpose of draining land must be placed nearer together or at a greater distance from one another, according to the degree of humidity of the field or meadow which they are intended to dry. The usual intervening space is from three to four perches. When the soil is of a highly argillaceous nature, and covered only with a very thin layer of vegetable mould, they must be brought nearer together.

Whenever the requisite materials for filling up the drains are procurable on the estate, the expenses of the operation of draining are trifling in comparison to the advantage the soil derives from it. In England this operation is very frequently undertaken by farmers who only hold their land on short leases, and yet they find that the outlay is amply repaid by the increase of fertility produced, and the consequent increase in the produce of the soil. This operation cost one of my friends who was advised by me to undertake it, and whom I directed how to proceed, one rix-dollar and sixteen groschen per acre, and the next year the produce of his wheat crop was increased two bushels and a half.

One necessary precaution which must never be lost sight of, is that of not allowing heavily laden waggons to traverse the ground thus drained in the direction of the drains.†

(*b*). The second cause of excessive humidity is generally

* See a work by this author, entitled "Anleitung zur Englischen Landwirthshaft," vol. ii. part 1, page 50; and also Count Podeivel's translation of "Johnston uber Anstrocknung nach Elkington."—Berlin, 1789.

† The German farmer evidently fell into the error, too common in England, that of placing their under-drain not sufficiently deep in the soil.

to be met with in valleys surrounded by hills, from which the water runs down and sinks into the land, or unites and settles on the surface in the form of ponds or stagnant marshes, without finding any outlet, and is, consequently, obliged to remain there until evaporated. When the soil of such valleys is not of a porous nature, and no drains have been formed in it, they of necessity become marshy, saturated with water, and often transformed into lakes or bogs. It is in general exceedingly difficult effectually to remedy matters when they have come to this state; but when taken in time there are many cases on record proving the immense advantages resulting from drainage, and in which the benefits derived have amply repaid the expenses: and this has been especially the case where it has only been requisite to choose the lowest part of the rising ground by which the valley is surrounded; or if there be such, some place hollowed out by the moisture, and there form a ditch of sufficient depth to carry off the water to the lowest spot, and thence to some river or lake. Previously to commencing such an operation, it is best carefully to calculate the expenses and outlay which it will occasion; and after comparing these with the advantages which may be derived from it, to decide accordingly.

Sometimes it is impossible to carry off the water to the lowest part of the valley, because there is not sufficient declivity there to admit of a course being formed for it. When once it has been clearly ascertained that these waters flow from the rising grounds, it may, in some cases, be advisable to intersect the declivity by a canal, or canals, for the purpose of collecting them. This canal ought to be situated at such a height as will admit of its being emptied from below, or by means of outlets carried across the lowest part of the rising grounds which enclose the valley: by this means a great portion, if not the whole, of the moisture will be got rid of. There is also a third means of remedying this evil, and it may be had recourse to when a layer of gravel or permeable sand exists beneath a thin bed of impenetrable soil. In this case one or more ditches may be dug through the impermeable layer, or wells sunk, or holes bored in the ground with a large draining auger, through which the water may filtrate into the porous stratum: this mode of proceeding has often been found sufficient to drain marshes, fens, and even lakes, and render the spots formerly occupied by them fertile land. But prior to the undertaking of such operations the chances of success should be carefully calculated; and we must ascertain whether or not when the water has reached this sandy or porous stratum it will be able to force a passage for itself; or whether the sand may not already be so completely saturated with moisture as to be unable to contain more, as is very frequently the case when the layer of it communicates with the surrounding heights. Under such circumstances the addition of fresh moisture will only tend to cause the water to rise up through the newly formed aperture, and flood the land which we desire to drain.

These evils may in some degree be remedied in fields exposed to them by intersecting the ground with numerous ditches, and raising its surface by the addition of the earth taken from these, or by supplies of sand brought from some of the neighbouring heights. The great fertility of the soil of valleys will often amply repay the outlay required for such an amelioration.

(*c*). In by far the greater number of cases, springs are formed in the following manner:—The moisture of the atmosphere being condensed in much larger quantities on the summits of mountains and in elevated situations, the water thus formed as well as that which falls in rain, sink according to the laws of gravity perpendicularly through the superficial porous earth until its descent is retarded or totally obstructed by an impenetrable substance; it then becomes dammed up, and is ultimately forced to filtrate slowly over this layer, or open for itself an outlet at the spot where this bed rises to the surface of the soil. Should it not find any channel here, it gushes forth in the form of a spring; if there is sufficient slope, it hollows a bed for itself, and descends over the lower ground in the form of a brook, without, however, making the adjacent soil damp. But when a quantity of porous earth is collected at the place where the impenetrable bed finishes on the declivity or at the bottom of the hill, the water sinks into it, renders a large extent of ground damp and marshy; and being forced onwards by the pressure which it receives from above, opens for itself passages, re-appears on the surface, and forms bogs and fens, or trickles over the surface.

This is one of the most frequent causes of humidity and of the formation of marshes or bogs.

On land of such a nature, recourse is frequently had to means which, although very expensive, are altogether fruitless, or at any rate productive of but little effect. A number of drains are dug, which only dry the land close to their edges; and, even when the most favourable direction is given to them, will, if not hollowed out to the impermeable layer, suffer the water to sink through them into the earth beneath, and thus become entirely useless. It is impossible that drains can ever be efficacious unless the bottom of them rests upon an impenetrable stratum; where such is not easily to be met with, they must be carried to a very great depth. It is therefore of the utmost importance that we should be enabled at once to distinguish the causes of the various kinds of humidity that are met with; and if proper attention is paid to the position of the divers strata of earth which give rise to the springs which we wish to get rid of, we shall find these causes reduced to a very small number.

On the slope, or at the foot of hills, the water does not usually flow directly over the horizontal or inclined layer of impermeable soil which prevents it from sinking into the ground. At the lower part of all hills, even such as are chiefly composed of stones and gravel, a primary layer of argillaceous earth is found; which, in general, gradually becomes thinner as it approaches the summit of the hill, and thicker towards the foot. In all probability, among other causes, this layer owes its formation principally to the particles of clay which the water has washed away from the higher ground, which it carries with it, and gradually deposits during it progress. The base of hills and mountains is generally found to be surrounded by a bed of argillaceous clay of greater or less depth. Thus we see that the water which sinks into the porous earth becomes enclosed between the impermeable layer and this primary stratum of clay, and a reservoir is formed which encloses more or less fluid, according to the quantity which falls from the atmosphere. This fluid escapes at the termination of the upper impermeable stratum, or else forces its way out whereever it is thinnest. In such cases as these, it does not present itself on the surface at once, because in general there is a bed of earth of that spongy, marshy nature, which is produced by excessive moisture, collected above the upper impenetrable layer. The water which escapes from beneath this latter saturates the porous bed, and renders a greater or less extent of ground wet and swampy, and thus forms bogs or fens.

The spring, properly speaking, or the place where the water gushes out from the clayey layer, is often higher up than the spot where the moisture begins to show itself on the surface of the soil; for when the bed of porous earth is tolerably large and the declivity rapid, the water sinks through, flows over the impermeable stratum, and does not show itself on the surface of the ground at all, at least during dry weather. Indeed, it seldom betrays itself until it reaches the bottom of the hill where the declivity ceases, unless it encounters elevations in the stratum of clay which impede its progress and force it up to the surface, or unless the bed of porous earth becomes very thin. These circumstances will occasionally cause the land to become wet, and to be injured by excess of moisture, even near the summits of mountains.

When, in digging a drain, the workmen come to the upper clay stratum, they should either make hollows in the bottom of the trench with a spade, or else bore holes in it with a boring auger, which shall perforate the bed of clay and penetrate into the sandy or gravelly reservoir, so as to give free vent to the water, which then gushes out through these holes with considerable impetuosity, and flowing along the drain, runs off into the connecting ditches prepared for its reception, and thence into some neighbouring river or brook. It will be understood that, in order thoroughly to produce this effect, the bottom of the drain must be higher than the level of the country below. Elkington made this discovery quite accidentally. He was standing upright in a ditch which he had caused to be dug for the purpose of draining the surrounding land, and which had turned out totally inefficacious, and in his vexation he struck the ground with an iron bar which he happened to have in his hand; this pierced through the layer of clay, which had previously been rendered thin by the excavation of the ditch; in an instant water gushed through the hole thus made with such force and rapidity as to compel him to retreat precipitately from the ditch. When he saw the effect produced, he made other holes with a boring auger, and by this means soon dried all the surrounding land. Subsequently, he effected the drainage of a number of spots where the performance of the operation with any degree of success had long been deemed hopeless, and thus acquired great celebrity. In digging drains, cases of this description very frequently present themselves; there are few workmen accustomed to this kind of labour who have not more than once seen the water rise thus from a bed of clay at the bottom of the trench.

By means of these drains, and of holes thus bored in the bottom of them with boring augers, an outlet may be made even in the lowest situations for the water collected in the beds of gravel, sand, or stones, which exist in the inferior part of the soil; and as almost all the reservoirs of water communicate with each other by means of the porous beds and veins contained in the ground, the whole of the moist land will thus be freed from its superabundant moisture.

By means of a drain thus pierced with holes at the bottom, all the land above the level for a considerable extent may thus be freed from moisture; that is, supposing the reservoir containing the water is reached: and thus all those springs which show themselves on the heights will be got rid of, provided that they communicate with one another by means of those veins or beds of porous earth I have already spoken of, as is usually the case. I have known instances in which, when this operation has been performed on one side of a hill, its effects have extended to the other, and drained it so completely as to cause a scarcity of water, while the drain has been so full as to contain water enough to turn a mill. Sometimes the water thus obtained may be employed with advantage in the irrigation of the same ground, which, having been thus freed from its superabundant moisture, may be transformed into watered meadows of good quality.

The holes formed by the auger do not easily become closed up; on the contrary, they are enlarged by the action of the water, and thus become artificial springs. A greater or less number of them must be bored, according to the quantity of water which will have to pass through. It is, however, as well to surround them with masonry, in order that, if the sides of the ditch should fall in, they may not be stopped up. This operation, it must be remembered, will not effect the drainage of any land below the level of the ditch.

I trust that I have been enabled to give a clear insight into the course which must be pursued, both for the purpose of collecting the water of these springs, and draining the land which they render wet. The principle of action is in itself very simple, but in order to put it in practice, a perfect acquaintance with all the circumstances of the locality, and a careful survey of the country, are requisite, as well as thorough and distinct notions of the various strata of which the soil is composed; and this not merely with regard to its surface, but extending also to its utmost depths. The nature and position of the different strata are sometimes accidentally discovered by noticing places in the vicinity of drains where the earth has fallen down; but this point can be much better ascertained with the assistance of the boring auger.*

(*d*). In order to prevent the overflowing of water-courses and rivers beyond their proper beds, and to diminish these beds when they are too large, recourse is had to the construction of *dams* and *banks*.

Notwithstanding the efforts of those talented theoretical and practical men who have turned their attention to the difficult and complicated art of constructing such banks or dams as shall be firm and durable, both the principles and application of this branch of science are yet, if not in their infancy, at least very undetermined. The forming and maintaining of high and extensive banks, as well as all matters relating to their execution and direction, is seldom undertaken by private individuals, but is usually a public concern, and is confided to the superintendence of skilful engineers, and men who are experienced in operations of this nature. Nevertheless, it may be interesting to agriculturists who reside near such places to acquire some degree of fundamental knowledge with regard to this subject, and read some of the works that treat of it.†

By means of banks or dams land is protected from the effects which might result from an excessive swelling of rivers, or from their subsequent overflowing, and land rendered capable of receiving cultivation which had previously been covered with water.

The means of constructing banks which are perfectly solid and durable is now well known. But time alone and the most frightful calamities led to the discovery of

* There is in Germany a translation of Johnston's work by the Count de Podeivel's, entitled "A Treatise on the draining of marshes and cold wet lands, according to the method discovered by Elkington." It was published at Berlin in 1799. In this work the subject which I have been endeavouring to explain, is entered into at great length, but in a very incomplete and confused manner. But with the assistance of what I have said above, a clear notion may be formed of all the cases mentioned there.

† "Hunrich's Praktische Anleitung zum Deich, Siel, und Schleusenbau." Bremmen, 2 Theile, 1770, 1782. "Kinchmann's Anleitung zum Deich, Schleusen, und Staatbaukunst." Hanover, 1786. "Riedel's Anleitung zur Strom und Deichbaukunde." Berlin, 1800.

the principles, without which the requisite degree of solidity could not be given them. Houses may now be built close by these dams or banks, without any fear or danger of their suffering from those accidents which are so frequent in our climate, and under our temperature; and which, in the vicinity of imperfectly formed banks, render constant and unremitted attention necessary whenever the water rises above its usual level. But even now, in the present advanced state of the science, these banks or dams are only capable of ensuring protection from those inundations which may be caused by the reflux of the sea and the action of the waves, the force and volume of which theory and practice enable us to calculate: but they are incapable of securing land from floods caused by excessive swelling of the river, arising from the thawing of masses of ice, because in this case it is impossible to calculate the volume or force of the power which the banks will have to contend against. In the latter case there is doubtless much to be feared; but when a large piece of land is left between the bank and the course of the river, and the current or course of the latter is made perfectly straight, or suffered to wind a little, these dispositions will afford more safety than the strongest or highest banks.

Unfortunately, in the formation of banks or dams, it too often happens that the work is performed in a great hurry, and sufficient care is not taken to see that the earth is made firm and solid; or the extent of space allowed for the passage of the water is too much confined, in order that more ground may be left for cultivation. From this carelessness and false economy, accidents and losses arise which greatly over-balance the value of the saving which is aimed at.

Even when these banks or dams are capable of preserving the land from being inundated or flooded, the soil is not freed by them from its superabundant moisture. The water which descends from the high ground to mingle with the water of the river must have some means of escape, and be prevented from remaining on the surface, or sinking into and saturating the ground. The means which may be adopted to prevent this are many and various; and we must be guided in our selection of them by the circumstances of the locality. Sometimes it may be carried off into the river by means of canals cut in as direct a line as possible, from which the water passes under the banks through sluices which open to give it passage.

These sluices are in general furnished with a kind of door, which the water in the river closes as it rises, and which is afterwards opened by the water in the canal when the former falls again.

By this means, damp moist lands which are situated pretty high, may in general be easily freed from their superabundant humidity; but not so land which is beneath the level of the bed of the river.

In cases of this nature, various imperfect modes of proceeding are resorted to; for example, the land is surrounded with drains and dykes for the purpose of carrying off the water which falls from the higher ground, and these are connected with canals which are raised above the level of the soil and convey it to the neighbouring river.

Occasionally, however, when the water cannot be kept sufficiently elevated, pumps or drawing machines are employed to raise it from the bottom of these dykes or trenches. But it must be borne in mind that ditches of this kind can only prove beneficial where the soil is of an argillaceous nature, and is tolerably solid. In light, porous land they would be perfectly useless.

We can only reckon with some degree of certainty on success when, by means of a drain of sufficient dimensions, we can cut off the water which descends from the hill in some spot above the level of the river, and high enough to enable us to direct this water into the stream which is to carry it off. If a drain of this kind has sufficient declivity, there is not a doubt of its proving beneficial; but it not unfrequently happens that mounds of sand are formed in its bed which obstruct the passage of the water, destroy the declivity, and, consequently, cause it to overflow, and thus transform land which was completely drained, into a bog.

It now and then happens that a third mode of proceeding may be adopted, namely, that of constructing dykes formed of solid earth all round the land, and emptying out the water from them with machines for drawing or pumping up water.

There are various kinds of these machines; but the greater part of them are worked by means of sails similar to those of a windmill. The inhabitants of Holland have surpassed those of all other countries in inventions of this nature. The most essential quality of this kind of machine consists in its requiring no other agent than wind to put it in motion, and being constructed in such a manner as not easily to admit of its being injured or put out of order; should such not be the case, it will be liable to become unfit for use at the very moment when most required. On this account those which require great motive power are very complicated, and, containing a great deal of iron-work, are always exceedingly troublesome. The "*drawing-wheel,*" the "*throwing-wheel,*" and "*Archimedes' screw,*" are, when well constructed, fully capable of effecting the purpose for which they are designed; but the "*hydraulic ram,*" a newly-invented instrument, is only adapted to particular situations. The "*Montgolfier*" machine, which has latterly so greatly attracted the attention of mathematicians and natural philosophers, is wholly inefficacious. Latterly, steam-engines have been made use of for this purpose with great success; but it must be admitted that they are very expensive.

It not unfrequently happens that it becomes necessary to make use of several of these instruments at once, in order to raise the water to the requisite height.

The same means which are resorted to in low situations, protected by banks or dams, for collecting and carrying off the water which falls from the height, may, with very trifling modifications, also be used to get rid of that which oozes or transudes through the earth, as standing water or fens. This moisture is occasioned by the water situated in the heights, which filters through the porous layers and veins of soil, and collects on the low flat land. When rivers overflow, the moisture thus produced in the land is not easily got rid of, even after the flood has subsided; on the contrary, it appears as if it was then only that the ground becomes thoroughly saturated. It often happens that the water does not ebb back to the surface until the river has resumed its usual position. This is one reason why these waters may not only be got rid of by means of canals which pass under the bank or dams, and have gates or sluices which open when the river is low from the effect of the pressure of the water in the canal, but also by dykes dug in an oblique direction relatively to the course of the river, in order that they may unite with the latter at the spot where the water in them has attained an equal level, or is a little higher than that in the canal.

When excessive moisture is occasioned not by standing or subterraneous water, but by the overflowing and oozing out of rivers, which, on account of their serpentine course, have not sufficient declivity, the best thing that can be done is to alter and improve the direction of the bed of the river, and remove all those obstacles which impede the passage of the water. The straighter its course, the more rapid will be the current; and the more rapid the current, the less considerable will be the volume of water resting on any portion of the bed at once. The fewer obstacles it encounters, the more gently will it flow onwards; and the more gently it flows, the less damage it is likely to do. The alteration may be effected in two ways. In the first of these, the windings of the river are cut through and its bed altered; and thus it is frequently materially shortened, rendered more sloping, and consequently flows much more rapidly and gently. In this manner a considerable extent of fertile soil admirably adapted for wheat or meadow land is often gained, and its produce soon repays the expense and outlay required by this operation. Should this mode of proceeding not appear advisable, a portion of the water in the river may be carried off without altering the former bed; but by digging a canal in the vicinity, which, from being straighter, has a greater degree of declivity. There is no necessity for making this canal very large at first, for the action of the water gradually tends to increase the size of it, until at length it becomes capable of containing and carrying off all the water in the river, and thus renders the previously existing bed entirely useless. This has been the case in the newly formed bed of the Oder, extending from Güstebinse to Niederwutzen.

Meadows situated on the borders of a river or stream that winds considerably, and the water of which rises above the surface of the neighbouring land, generally suffer greatly from humidity. This evil may, however, often be remedied by digging a ditch or drain along the meadow, from its upper to its lower part, which drain is made to open into the river at the point where its bed is lower than the surface of the meadow. This drain will speedily carry off the overflowings of the water, especially if its operation is facilitated by the addition of smaller drains leading into this one. The earth which is extracted from this drain will sometimes be sufficient to form a bank along the side of the river, when the distance to which it must be transported for this purpose is not too great.

In countries much intersected with streams and rivers, it very frequently happens that the low grounds in the vicinity of these are so considerably below the level of their beds as to render it impossible to carry off the superabundant water with which such land is saturated by means of the river. In cases of this description, after having enclosed the highest parts of the river with banks or dams, the ground may be drained by means of pipes or tunnels passing through these banks and under the bed of the river; or else by covered drains formed of mortar or mansonry, through which the water is carried off to some lower brook. Cretté de Paluel, a most distinguished French agriculturist, made trial of this mode of proceeding in two different places. I shall extract an account of the operations from the "Memoirs of the Agricultural Society of Seine," vol. iv., both because they furnish examples of an operation which occurs but seldom, as well as because these two cases are very instructive, on account of the number, nature, and variety of the circumstances relating to them.

"All this," says Cretté, when speaking of a great extent of drainage which he had successfully accomplished, "have I effected; and any one who chooses may come and satisfy themselves by seeing it." "There is, however, one rule from which I never depart," he says in another place, viz., "that of conducting all my operations and undertakings on a liberal scale, and never suffering any false notions of economy to mar the whole. The soil amply repays the capital which is bestowed upon it, provided that it is skilfully and judiciously bestowed; but those who act parsimoniously, and grudge every farthing, can never expect to derive any great profits; the enterprising alone will find their endeavours crowned with success: this observation relates particularly to draining."

On the Draining of various kinds of Marshes.

We class under the denomination of marshy all those uncultivated lands which are of a spongy nature, and always saturated with water.

They are divided, first, into *green marshes, swampy bogs,* or *meadows:* this variety comprises those which are covered with a layer of turf, or of high grass, which finds an abundant supply of nutriment in the upper stratum of the soil. And secondly, into *peat marshes, sterile bogs,* or *furze land,* on which nothing but mosses and a few other plants grow, as the yellow star of Bethlehem (*ornithogulum luteum*), marsh ledum (*ledum palustre*), sweet gale or myrrica, common and crop-leaved heath, (*erica vulgaris et tetralix*), &c.

Marshes of the first class, although constantly moist and wet, yield some little hay, but this is in general far from being nutritious; it is unpalatable to cattle, and very often unwholesome; besides, it can only be secured in very dry seasons: cattle cannot be pastured on such land without danger.

Peat marshes yield scarcely any pasturage, and no produce; but the peat which may be obtained from them is very valuable.

Neither of these varieties can be rendered fertile until the soil is thoroughly drained and rendered healthy; and this drainage must be effected by such means as the nature of the circumstances may seem to indicate. Considerable sums are often expended in this operation to little or no purpose, on account of the cause from which the wetness arises not having been clearly ascertained in the first place.

If the superabundant humidity of the soil is caused by the stagnation of water which falls from the neighbouring hills and elevations, and settles in the valleys and on the low grounds where it can find no vent, and where an impermeable layer of earth prevents it from penetrating deeper into the soil, the first thing to be ascertained is whether or not a canal, the bottom of which shall be on a level with the marsh, can be dug on the declivity of the neighbouring hill. If the expenses attendant on the formation of such a canal do not exceed the profits which may be expected to be derived from the advantages resulting from the drying of the marsh, it should be immediately attempted; the canal should be formed after the manner which we shall presently direct.

But where such a mode of proceeding is impracticable on account of the marsh being surrounded on every side with high grounds, recourse may be had to another mode of operating, which consists in finding an outlet for the water through one of the inferior strata of the soil; but this can only be effected in places where the marsh is above the level of the surrounding country, or of the nearest river or pond. It is very seldom that marshes situated on plains can be drained by means of the sub-strata of the soil; but where it is possible to have recourse to this mode of proceeding, and where holes are bored in the bottoms of the drains intended to carry off the water, these latter may be filled up with rough stones and afterwards covered with earth, as the water will have room enough to flow between the stones. When the marsh is once drained, other ditches may be connected with these drains, which may also be covered up after having been filled with branches.

If, as frequently happens, the dampness arises from springs, the essential point is to discover the level or height at which these break out. Sometimes they show themselves at the edge of the marsh, in a position rather higher than that of the spongy earth. When in this position they may be carried off by a drain, or by holes bored in the soil with an auger, and the marsh thus dried without the necessity of cutting through its whole extent. By this means the important advantage of gathering the water on the highest spot is attained, and thus being able to carry it off with greater facility. In general, the only way of conveying it to some brook or reservoir is by excavating a canal of some size along the bottom of the marsh. If, on the other hand, the springs rise ever so partially from the bottom of the marsh, there is nothing can be done but to form a large drain or canal for carrying off the water across the marsh; which canal shall be on a level with the bottom of the spongy stratum, and formed in the moist soil after the manner which we are about to describe, in order that the water contained in it may be conveyed away from the land through a conduit of solid earth.

If the humidity of the morass is occasioned by some reservoir of water, either in the vicinity or at a little distance off, the surface of which being generally or occasionally above the level of the marsh, communicates with it through the permeable strata, or else by means of the veins of the soil, a state of things which will occur even when the morass is separated from the water by a high hill, the first point to be ascertained is whether or not it is practicable to carry off the water by means of some spot, or through some drain situated lower down. Sometimes it is impossible to get rid of the water, otherwise than by means of an open canal or trench leading towards the place where it rises from below the surface: this is the case in places where rivers overflow and then return to their former bed. When these rivers are surcharged, a portion of the water contained in them being compressed by that which is above it, penetrates into the surrounding earth, which it slowly filtrates through, and runs into adjacent land, or even into land at some distance: it often happens that the period when the moisture of the land is most apparent, is exactly that at which the river subsided: the water remains in the spongy soil, rendering it moist and unfertile; until by degrees it is evaporated, or rejoins the river. The evils resulting from these circumstances may be remedied by digging a ditch, which shall, when the river has subsided, carry the water either directly or indirectly back to the river at some lower point. Every time there is an overflow, the mouth of this ditch or canal should be closed by means of a gate or sluice, unless it is the intention to irrigate some portion of the land, and it should be opened again as soon as the water has subsided. For this purpose, as I have before said, sluices are made use of, which open and close of their own accord.

A marsh cannot be intersected with ditches until the chief drain has been formed in the solid ground. When the morass is large and deep, this can seldom be effected at once, but must be the work of several years; because the spongy substance of which the marsh is composed is so full of water as to render it impossible to make the drains of the proper depth. In the first place, the principal drain is only excavated to the depth of a few feet, or as far as the moisture will permit. The following year this ditch is deepened, and not only extended in a direct line, but also made to throw off ramifications from its sides in various directions. On the third year the water will be so much dissipated, and the surface of the soil so much dried that the principal drain may be excavated to the requisite depth, and both that and the ramifications extended. The spongy matter which had been swelled up by the water, will then decrease in size and sink down until the drain becomes scarcely half so deep. This substance also contracts as it dries, so that the drain becomes wider and acquires a slope which it had not before, and which is never given to drains of this description.

Those marshes which contain a certain thickness of peat, may be brought into cultivation either without the peat being removed or after that operation has taken place. I shall not enter into any particulars respecting the removal of the peat,* but confine myself to what has relation to draining and cultivation, properly so called; but this cultivation can only be bestowed on turf pits which have been regularly worked out. When a marsh is no longer to be maintained for the sake of its peat, but is to be brought into cultivation, it is usual to leave a thickness of from nine to twelve inches of peat. Care is always taken to restore to the soil all the black earth which was attached to the peat. Wherever it is possible this black mould is mixed with fresh soil, procured from some neighbouring spot or from the land itself, either from the sides of the drains or by digging in various places and excavating beneath the peat. The peaty mould thus receives a greater degree of consistence, and is rendered capable of bearing all kinds of crops. If, at the same time, an amelioration of stable manure can be bestowed on the land, or, what is equally efficacious, a plentiful amelioration of lime, the soil becomes at once excessively fertile; it must not, however, be made to bear consecutive crops of grain unless its fertility is maintained by repeated manurings. In Holland and in Friesland, it is well known that if we would preserve the fertility of the soil we must lay it down as pasture land for a while, or an abundance of manure must be procured for it by

* Because we have a standard work on this subject entitled "Eiselens Handbuch oder theoretisch praktischer Unterricht zur Naeheren Kentniss des Forstwesens." Zweite Auflage. Berlin, 1812, A.

making it bear alternate crops of grain and fodder. The immense produce yielded by land that has once been a peat marsh, causes all landed proprietors to lose no time in bringing these portions of their estates into cultivation, as soon as they have taken off the peat; and not, as formerly, to be content with the trifling profit arising from the renewal of the peat.

If the operation of draining has been properly performed, the land will be as well adapted for the growth of corn as for meadow land; and should the latter be preferred, it can in general be well watered by means of more or less complicated arrangements. But where the drainage has been imperfectly effected, it will be better to form plantations of alders and willows upon it, as these trees grow very rapidly, and yield a great deal of fire wood; which is much more valuable and useful than the newly formed layer of peat would be.

Where it is impossible to manure the land, the plants of which the peat was formed will at first continue to shoot up here and there, but these will gradually give way to other and better ones; especially if the under part of the soil is tolerably dry, and the land well watered and irrigated.

When marshes, from which the peat has not been taken, are drained, or such land as is covered with reeds, rushes, or plants of a similar nature, they may be broken up with a plough; or, if not firm enough to bear the pressure of the feet of the horses, tilled with a mattock.

When the dry season comes on, the ground thus turned up should be set on fire, and the combustion commenced from the side on which the wind blows; thus, both the peat and the roots of all the plants will be reduced to ashes very speedily. Some persons advise the land being burned without being ploughed, but the advantages attendant on such a course of proceeding are neither so great or so certain, because the action of the fire cannot be carried to a sufficient depth; nor is it so uniform, and therefore the roots of the plants are only partially, if at all, destroyed. Where the marsh is excessively spongy, and consists chiefly or solely of vegetable substances, it is almost impossible to calculate on its being thoroughly drained. The inequality of the effects of the burning can never be wholly remedied norprevented, nor the asperities thus formed avoided, but the latter may easily be got rid of.

After the operation of burning has been performed, no time should be lost in burying the ashes and mixing them with the layer of earth immediately underneath. Formerly it was customary to sow land thus prepared with buck wheat for several consecutive years; this plant was invariably found to succeed, and greatly loosened the peaty soil; but now, potatoes and turnips are in general cultivated, which answer the same purpose and generally yield an immense produce, and the ground is subsequently sown with rye or oats, which thrive very well, and the grain of which contains a peculiarly white flour: this property is occasioned by the ashes. The spring turnip likewise answers well on this kind of land. Barley, wheat, and autumnal rape do not succeed at all on such soils; at least until they have been ameliorated by a considerable addition and admixture of marly or argillaceous earth, or even of pure sand. After this has been done, almost any kind of crop may be sown with success.

But it must be borne in mind, that land thus brought into cultivation requires regular ameliorations of stable manure, without which it soon begins to show signs of exhaustion, and must be left at rest, or only used as pasture land; the produce of which will be greater or less according to the degree of impoverishment to which the soil had been reduced by previous cropping. Sometimes land of this nature is made to bear a succession of crops until it is absolutely incapable of producing any thing more; when such is the case, the only way of restoring its fertility is to leave it at rest for a considerable period, and bestow repeated ploughings and ameliorations on it during that time. Some say it is a good plan to burn it again, and assert that its fertility is thus renewed.

IRRIGATION.

Almost all agricultural writers have combined the relation of all particulars relating to irrigation with instructions concerning the cultivation of meadow land. There is, however, a species of irrigation which is not intended to fertilize meadow land: from the remotest ages this operation has been had recourse to for the improvement of wheat land, and of land devoted to the growth of other crops; this is especially the case in warm climates. We shall, therefore, now speak of general irrigation, and leave the consideration of that destined simply to benefit meadow land until we come to that division of our subject.

Irrigation will be found to be connected in more ways than one with the subject which we are now upon, viz., draining; because both these operations must be preceded by the same research, and the same inquiries as to the level or height of the water, as well as because the rules laid down for the formation of drains will be equally applicable to that of irrigating canals: and the draining and drying of land must, of necessity, precede its irrigation, and is intimately connected with it. In fact, one of the most essential points required in a soil which we wish to irrigate is, that there shall not be the slightest trace of moisture in its inferior strata, but that it shall be thoroughly dry; wherever such is not the case, irrigation, so far from proving beneficial, will inevitably be productive of the worst possible effects. But there are many cases in which it is easy to collect the moisture which settles below the surface of the soil and there become stagnated, and carry it off to such a position as will enable us to employ it with advantage in the irrigation of those very soils which it previously rendered damp, unhealthy, and sterile. Lastly, irrigation can never prove really beneficial, excepting where we can turn off the water from the land at pleasure, and drain it again immediately after it has been watered.

Irrigation certainly is one of the most useful and important of all the operations that come within the province of an agriculturist. It is well known to all persons that moisture is an essential condition to vegetation, and that water, either directly or by its decomposition, contributes materially towards the nutrition of plants. The difference which exists in the fertility of various kinds of land depends chiefly upon their greater or less disposition to retain moisture. Sandy soils, which, on account of the facility with which water evaporates and escapes from them, are regarded as almost if not absolutely sterile, may be rendered as fertile as the richest argillaceous land, and equally capable of producing the greater part of our most valuable crops, and certainly of our most useful vegetables, if care is taken to preserve them in a proper state of humidity; that is, provided they contain a sufficient portion of soluble humus. Where this is the case, a sandy soil is often found to be better adapted than any other to most of our profitable crops; it is peculiarly favourable to such as are liable to suffer from excess of moisture. When the requisite arrangements have been made for watering the soil, such a degree of moisture or of dryness may be communicated to it as best agrees with the nature of the plants which it has to bear.

Almost all water carries with it fertilizing particles which are exceedingly beneficial to vegetation. Water which has stood for some time on the surface of a soil will always contain nutritive matters which it has collected during that period, and the quantity of them will be proportionate to the richness of the land over which it has passed.

This nutritious matter, which would otherwise be precipitated into the depths of the sea and lost, is retained by means of irrigation and deposited on those soils which are watered, where it contributes to the maintenance of fertility, and to the reproduction of new plants. Water which rises from the ground usually carries with it particles of lime or gypsum (sulphate of lime) dissolved in carbonic acid, and consequently divided into impalpable molecules. When the carbonic acid disengages itself in the air, these two substances which are so favourable to vegetation become precipitated on the watered soil. It is on this account that the efficacy of irrigation is so much greater on that portion of the land which lies nearest to the spot where the water rises, and where it contains the greatest quantity of lime.

By means of irrigation we obtain and make use of a species of manure which would otherwise be lost to vegetation, and which could not be obtained in any other way; and we procure a crop which produces fresh manure without having required any in its production. Thus we, in a manner of speaking, create in our land fresh elements of vegetation.

Irrigation renders us in a great measure independent of temperature; for by means of it we are enabled to do without rain for a considerable period, as is evident from the fertility of the watered lands in the warm, dry climate of Italy, where it often happens that not a single drop of rain or even dew falls for at least four months.* We are also enabled by its means greatly to diminish the mischief done in the spring by white frosts or by frosts in general, because the water, especially when it rises from fresh springs, warms the soil by its higher temperature, covers it with verdure, and renders the meadows luxuriant at periods when land, which has not been watered, scarcely shows any traces of grass; and because the water, whatever may be its properties, diminishes the pernicious effects of frost of all kinds on plants when it is suffered to pass over them in the spring. By means of irrigation, we are often enabled to produce an eminent degree of fertility in land, which before yielded but a very small amount of produce. These are, I should imagine, sufficient inducements to set about the formation of arrangements for watering land wherever it is practicable so to do.

It not unfrequently happens that every facility presents

* The dews appear to me to be much more heavy and abundant at Romagna than they are in France and Italy; and it is to this circumstance I am inclined to attribute the slight effect which drought seems to exercise over plants in the former country compared with those in the latter.—FRENCH TRANS.

itself for undertaking this operation on a most extensive scale. There are many districts, and even whole provinces in which there is no spot, however distant from or above the level of the water it may be, which cannot with proper management be made to participate in all the advantages resulting from irrigation. If all the natural water-courses were intersected at their highest point, and the water retained in canals formed at a proper elevation, it might be made to irrigate countries where at present such a thing is scarcely dreamed of.

But even when large establishments for the purpose of watering land, which require the concurrence of several landed proprietors to perfect them, and which must be supported at public expense, cannot be formed, it very frequently happens that a considerable extent may be irrigated where such a thing has never before been attempted. Hitherto, when landed proprietors or agriculturists have determined upon irrigating their land, they have only directed their attention to the low grounds in the vicinity of some river or brook, although these are the very positions in which the operation is productive of least advantage, and they have totally overlooked the higher and rising grounds where it would have been incalculably more beneficial. It is a fact which is demonstrated both mathematically and physically, although often disregarded or misconceived, that water which flows on an elevated or rising ground, must, of necessity, extend itself both laterally and horizontally when its course is impeded and it is prevented from descending to the lower parts of the country; consequently, it can be conducted to all those spots which are not above the level at which it was arrested, provided that we are enabled to prevent it from sinking into the earth.

In general, water which descends from some height to a lower spot with more or less impetus, that is to say, with greater or less swiftness and force, and passes across some country, hollows for itself a bed in the lowest parts of the country and there forms divers windings and sinuosities. Every brook, therefore, flows in a valley of greater or less extent, surrounded with higher ground. It frequently happens that when we consider these heights from the bed of the brook or river, they appear so elevated that many persons can scarcely conceive how the water which flows along the valley can by possibility be carried to them. But a careful levelling will prove that the point at which the water enters the valley is much higher even than these rising grounds, which at first sight appear inaccessible to the water. If, then, we cut off the water by means of a sluice or weir at the highest point, which we will suppose to be a height of 800 perches; and if above this sluice we dig a canal which, taking the water from the bed of the brook, carries it on at an equal height and with as little slope as possible, this water may be made to irrigate all those parts of the hill bordering on the valley which are a few degrees below the point at which the stream was cut off.

Experience and skill will, doubtless, do much towards enabling us to perceive at once the best way of turning to account the water and land at our disposal. But, however well acquainted we may be with the details of the operation, we must never rely too entirely on these, but before putting any plan, however feasible it may appear, into operation, take levels in all directions and from all points most carefully, and test each observation by repeating it again and again. We shall thus be able to ascertain how far our first estimate was correct, and shall become convinced of the possibility of carrying water to heights, where such a thing at first sight appeared impracticable. While, on the other hand, we shall often find that many places to which we had fancied the water might easily be carried, are much too high.

It is not sufficient to ascertain the height of the places to which we intend conveying the water, but we must also find out that of all those spots through which it is to pass. All hollows and low places should be as much as possible avoided; and, to effect this, it is often necessary to take considerable circuits. Sometimes there is no other means of keeping the water up to a proper height but by making it pass over raised courses formed of earth, wood, or materials collected for the purpose. Recourse is had to this mode of proceeding when the spot from which the water is taken is separated from that to which it is to be conducted by hollows. The chief thing to be attended to here, is carefully to examine and calculate whether the advantages anticipated from carrying the water over these hollows will be sufficiently great to repay the expense of the conduit, and if there is a sufficient quantity of argillaceous earth in the vicinity to form a solid canal.

A wooden conduit or canal will often be found least expensive; but it must be remembered that such an one is much more liable to decay and injury than any other.

In some cases, when the water has to pass over a very deep soil or to be carried above another water-course, the best plan is to form an arch of stone or brick work, and construct an aqueduct above it. But here, also, the advantages resulting from such an operation must be brought into comparison with the expenses of it.

When the levels of the water-course have been taken, the next thing to be done is to ascertain the quantity of water that can be procured, in order that the canal may be made of a suitable depth and dimensions. To do this, the quantity of water which can be found at each season of the year must be noticed, and we must take as an average that which can be collected at the driest period; for it would be perfectly useless to make a canal of large dimensions when there is not water enough to fill it.

However small may be the amount of water which we have at our disposal, it is possible to derive great benefit from it; and to ensure this, we have only to use it as economically as possible, to collect it as soon as it has fulfilled its purpose, and use it on some lower surface, re-collect it and diffuse it over a third portion of land, and so on; but all this requires careful and skilful arrangement, for each portion of land must be made sufficiently sloping to admit of the water descending over it, and being collected at the bottom; and yet this slope must be very gentle, in order that as little of the height may be lost as can be avoided, and that the water may be extended over as large a surface as possible before it returns to its former bed, or to the canal which is to carry it away.

Attempts have been made to demonstrate on mathematical principles the extent of land which can be irrigated by a certain quantity of water. Hypothetically speaking, this might certainly be done, but the results of theoretical and practical experience are seldom the same, because it is impossible to calculate with any degree of precision, either the swiftness or force with which the water will flow, or the absorbing powers of the soil. A certain accuracy of eye, which enables its possessors to judge of this point at a glance, and which can only be acquired by experience, will lead to more accurate estimates than any measures or calculations. When there is no means of acquiring this experience on the spot or in its vicinity, on account of there being no undertakings of a similar nature formed there, the best plan is either to visit districts where they do exist in great numbers, or to obtain the advice and co-operation of persons who are in the habit of conducting such operations. It now and then happens that the quantity of water, especially when it flows from lakes or places abounding in springs, may be increased by enlarging the opening through which these lakes, or this collection of springs pour themselves, because by so doing we diminish the counter pressure which stagnant water opposes to that which seeks to unite with it. In consequence of this enlargement of the opening through which the water is emitted, the springs and their veins open more, the water falls from the heights with greater impetus, and opens for itself a passage through the obstacles it encounters with much less difficulty.

This observation relates particularly to those lakes which have no apparent outlet: when one is made for them they fill much quicker than before, and supply the canal with a larger quantity of water than could have been anticipated before this operation was performed.

A third point, which in many cases it is very necessary to ascertain, is, whether we have undisputed possession and right over the water and land which we propose operating on; whether we can act without being interfered with by any of our neighbours whose farms or estates lie above or below us. Such interference is but too frequent on land in the vicinity of mills, for those millers whose establishments are immediately above the place from which the water is derived, exclaim that the stream will be turned to flood their mill-dams, while those living below fear lest they should be deprived of that supply of water which is necessary to their trade. However futile and wholly without foundation these fears may be, it is often utterly impossible to prove that our arrangements for watering our land are not injurious or detrimental to the mills and property around, at least we shall find it very difficult to do so with sufficient perspicuity to meet the comprehensions of those tribunals before which the case is brought, for they are in general composed of men who, from prejudice and habit, adhere strictly to the letter and spirit of that law and those ordinances, which, being made when the science of agriculture was in its infancy, sacrificed all general advantages to secure the safety and rights of mill-owners. There will, therefore, be every danger of our being invariably worsted in litigations on this point, and compelled to relinquish our projected plans of improvement and amelioration on account of the ignorance or egotism of the miller. It not unfrequently happens that other persons residing in the neighbourhood think that they have some reason or right to oppose the progress of the operation: for example, those whose land is situated above, torment themselves with the idea that it will be impossible to close the sluices when the water rises, and, consequently, that their property is exposed to inundations; and, however absurd this notion may appear, it is one very likely to occur to ignorant or prejudiced people: those who reside below, on the other hand, fear lest their supply of water should be diminished, or that the water will come to them loaded with mud, dirty and impure. Whatever hope may be entertained that the enlightened spirit of the present age will lead to the formation of enactments more favourable to the interests of agriculture, it behoves us, in the present state of things, to act with circumspection when about to undertake an operation of this nature.

Lastly, it will be necessary to ascertain whether it will be possible to form or find a vent through which the water may be immediately conveyed away from the land which has been irrigated, otherwise we shall do more harm than good; and, instead of ameliorating the soil, shall, in all probability, render it damp and marshy. In by far the greater number of cases, however, this point may be easily accomplished.

The various ditches or canals for the purpose of irrigation may be classed under the following heads:—

1. The *principal canal* or *head drain*, is that branch which furnishes the land we propose irrigating with water, and which retains this water at a proper height. The bottom of it ought to have very little slope, an inch in twenty perches is quite sufficient. Its width must be determined by the volume of water which will have to pass through it; as to its depth, that will depend upon the greater or less elevation of the soil in different places above the horizontal surface which forms the bottom of the canal, and the slope given to its sides must be regulated by the depth.

2. The *secondary canals* or *small mains*, are those which convey the water from the principal canal or main, or from some other ditch towards the spots which are to be irrigated.

3. The *trenches* are those which give out the water on to certain portions of the land to be irrigated; these are usually furnished with small banks through which are bored.

4. The *openings* or *holes* by means of which the water is distributed. As it would be impossible to give that degree of evenness and regularity to the edge of the

trenches which would admit of the water escaping in an uniform proportion from every part of their whole length, we are compelled to have recourse to these openings, which, as they will have to resist the pressure of the water, must be made tolerably strong, and surrounded with thick turf, or lined with wood. They are not unfrequently formed of wooden rings, or of a hollow branch of willow inserted through the bank or side of the trench. It is necessary to be enabled to increase or diminish the quantity of water which passes through these openings at pleasure, and this may be done by placing turfs so as to impede the passage of the water, or small pieces of board or wood. When the meadow is not of an uniform height, these openings are made in the upper parts. From them the water passes into

5. The *furrows*. These are either situated a little behind the bank of the trenches, or at right angles with it. It is by means of these furrows that the water is distributed over the whole surface of the soil.

They should not be too long. Twenty-one perches ought to be their utmost length: if they are made longer they soon become choaked by the rapid vegetation of the grass, and the water never reaches to the extremities; the longer they are, the wider should they be made at the mouth or commencement, because the space which has then to be watered by them, viz., that comprised between the irrigating furrow and the drain, is rendered more extensive, and requires a larger quantity of water. It is needless to observe, that the openings that convey the water into the furrows must be proportionate in diameter to the width of the furrow. The furrows are usually formed by means of a spade slightly curved, which we call a furrowing spade, and a species of large turf knife which is used to cut the turf on both sides of the furrow; or a plough is made use of which is contrived expressly for the purpose.

6. *Canals* or *drains for carrying off the water*. The size of these should be proportionate to that of the irrigation canals, and they should always correspond with each

other. The water must be collected from every part of the land by drainage furrows, which will conduct it to the trench intended to carry it off. It is these means of getting rid of the water at once which distinguish irrigated land from that which is damp and marshy, and without them it is impossible to obtain that increase of fertility and of produce which may, under proper arrangements, be anticipated from this operation.

The canals intended for the purpose of carrying off the water are similar to those which convey it to the land. The *principal canal* or *drain* is that which receives and carries off all the water which flows from the whole surface of the irrigated land. Sometimes it is the bed of that same river or brook from the superior or upper part of which the head main or chief irrigating canal is supplied. The *secondary canals* are those which take up the water from a part of the irrigated land, and convey it either to the principal canal, or to some fresh portion of ground which is to be watered; where the latter is the case, this *secondary drainage canal* becomes in its turn a *secondary irrigating canal.* It very frequently happens that canals of this class fulfil both these purposes; first, receiving the water which flows from the upper parts of the land, and then conveying it to irrigate the lower portions.

It not unfrequently happens that the trenches for carrying off the water are furnished with little banks to prevent the water from escaping too rapidly, and openings are made through these banks which may be closed more or less; but this is oftener done when the land is watered by inundation, than when by irrigation.

7. The term *ditches* or *trenches* of *reunion,* is given to those which are intended to collect the water which flows from high grounds, and bring it to a canal raised above the level of the soil, or some large place, as for example a pond or reservoir, in which it is retained by means of a strong bank, in order to be conveyed at a yet higher level over ground, which could not otherwise have received the benefit of the operation. When the trenches for carrying off the water are intended to fill this second

purpose as well, they must be constructed with infinitely more care and attention.

It is impossible for any irrigating establishment to be able to do entirely without sluices of various kinds.

The construction of these sluices comes under the province of hydraulic architecture, and therefore I shall refer my readers to various works which treat of this subject.*

The *principal sluice* or *weir*, that by means of which the course of the river is impeded, and the water forced to enter the head main, is usually the largest and most expensive: indeed it not unfrequently constitutes the chief item of the expense. Many persons have on this account endeavoured to do without it, and to substitute a dam in its stead; but there are very few cases in which the course of the water can be thus permanently cut off without doing mischief, and still fewer in which it is possible to pierce those dams when required, and afterwards re-establish them.

If the benefits attending irrigation can only be extended to a small portion of the land, the expenses attending the construction of such a sluice when compared with that limited extent of surface would be very great; but where a large portion of ground can be irrigated, the expense when divided among this number of acres will be but trifling compared with the advantages accruing.

The other sluices required by the head and smaller irrigating mains or canals, as well as by the drains, may be lighter and of more simple construction, because they will seldom have to contend against the pressure of any great volume of water. The number of sluices which must be formed, will depend upon circumstances; in general, however, every portion of ground which has its own particular furrow for carrying off the water, ought to have a separate sluice. These sluices are sometimes so contrived as to cause the water to flow back to the summit

* In the "Annalen des Ackerbaues," vol. ii. p. 529, will be found a circumstantial description of the sluices and other contrivances requisite for irrigations on a small scale. See a very interesting paper entitled "Abhandlung ueber eine Wiesen bewaesserung."

of the ditch or canal; and, at others, so as to prevent it from rising above a certain height, and so that the superabundance shall fall under the sluice. In the latter case, a dam may often be substituted for the sluice.

The whole of the undertaking should be conducted on a liberal scale; for it must never be forgotten that the expense of repairing things or work that has been badly executed, or formed of common materials, far exceeds the cost of good and solid work and materials in the first place; besides, the inconveniences produced by any of the parts getting out of order are often great and serious.

In many cases, in irrigation as well as in draining, recourse is obliged to be had to subterranean conduits or pipes, made either of wood or masonry, in order to carry the water under a dam or road, or under another water-course. These subterranean canals are also frequently furnished with sluices or hatches, in order that the water may be retained or suffered to flow on as seems best.

It is often requisite to form bridges either of wood or masonry over a water course. When these are composed of brick work, the canal must be carried on by an aqueduct; and as constructions of this nature are liable to accidents, and to be overthrown or torn up when the volume of water becomes increased, which may lead to serious inconvenience and mischief, we must avoid, as far as possible, having recourse to this plan. Dams or mounds of earth raised upon land for the purpose of bearing a canal, which is intended to transmit the water from one height to another, often cost large sums of money; and if not constructed with the utmost care and attention, are liable to accidents. It now and then happens that, by turning and altering the course of the canal, it is possible to do without these altogether; and such a course is advisable, even though it may appear to be equally, if not more expensive.

There are three ways of irrigating land:

1. By *inundation*.
2. By *irrigation*.
3. By *causing the water to flow back in the ditches*.

In some localities matters may be so arranged as to admit of each of these modes of proceeding being alternately adopted, according as they seem best calculated to attain the end in view.

Inundation requires that the land which is to be operated on should be surrounded, either naturally or artificially, with a small mound or bank capable of retaining the water on the inundated surface.

Sometimes land is inundated by impeding the natural course of the river by means of a sluice or weir placed across it immediately below the point to be inundated, by which the water is forced to flow back and extend itself over a certain surface. But this can only be effected in particular localities, and then in a very imperfect manner, because we cannot then regulate the quantity of water, the duration of the inundation, or obtain that immediate and perfect drainage which is of so much importance. It often happens also that it is impossible to confine the water within the prescribed bounds, and when rapid streams swell up the impediment to their course presented by the sluice, will occasion serious floods, and cause the water to wash away the soil and form embankments.

Inundations which are effected by means of an irrigation canal, which derives its water from the upper part of some river, are infinitely preferable; and especially as it is only by means of them that we can procure the advantages resulting from the watering of grounds which, though high, are below the level of the water at the spot where it passes from the river into the canal. It is likewise in this manner only that we are enabled to drain the whole extent of inundated ground at once.

Inundation possesses some few advantages over irrigation. During the winter and spring, when there is so much water, and when it is most charged with fertilizing juices and particles, we can use it thus, and retain it upon the land until it has deposited all the thick mud and slime which it bears with it. By this means the ground becomes thoroughly impregnated with water; and if a spongy soil is inundated, and then drained through its inferior stratum, it will be found to have acquired consistence and solidity.

On the other hand, this mode of watering land can only be adopted in autumn, winter, and spring, and must not be attempted when vegetation and heat commences. After the first crop of hay has been gathered, it may sometimes be had recourse to, but only in a very superficial manner. When I come to speak of the cultivation of meadow land, I shall enter more fully into the subject of the necessity of ensuring the means of carrying off the water and draining the soil as quickly as possible. At present I shall content myself with repeating that the furrows and canal for this purpose must be carefully and systematically formed, must be proportionate in size to the quantity of water which is to pass through them, must have a sufficient slope from all parts of the surface which they are intended to drain, in order that the water may flow off evenly: these points are indispensable if we would attain all the good effects which may be anticipated from irrigation.

But as this mode of watering land cannot be had recourse to in the summer, when it is necessary to prevent those soils which have profited by it during the winter from becoming too dry, watering by irrigation is, upon the whole, preferable; especially for land which, from its nature and situation, is liable to suffer from drought. The water deposits those fertilizing substances which it carries with it almost as much in irrigation as in inundation, particularly if the same water is made use of several times over, and each time on a fresh portion of land; a circumstance which cannot take place in any other kind of watering. But the chief advantage of irrigation is, that by its means we can, at all times and in all seasons, bestow exactly that degree of humidity upon the soil which is required by the plants it bears.

Land is generally irrigated in autumn, winter, and spring, for the purpose of enriching and fertilizing the soil; but the operation may be continued after vegetation has commenced, and even when the plants have risen to a considerable height above the ground, and may be repeated as often as the temperature of the season and the nature of the soil and of the plants may appear to require it. Sometimes meadows are irrigated during the night preceding the day on which they are to be mown, in order to make the grass fresher. The ground is always watered in nights succeeding to very hot days, and this irrigation is highly beneficial to the grass, making it green and luxuriant; while that growing on land not submitted to this operation is withered and dried up. Were it not for this operation, the agriculturist would never be able to contend against all the uncertainty and extremes of temperature and climate; whereas, by its means, he nullifies the prejudicial effects of cold nights and white frosts, as well as of intense heat and drought. As the water is kept in constant motion during the process of irrigation, there is no fear of its producing putrefaction, or occasioning those miasmas which arise from stagnant water during dry weather.

The grass which shoots up under the influence of this kind of humidity is adapted to all kinds of cattle, and that which is eaten while green on the pasture does not injure the animals as grass does which grows on naturally damp moist land. It is of course understood that the cattle must not be turned upon land thus watered until it has been thoroughly drained. When there is a sufficiency of water for the purpose, and every requisite care and attention is paid to the operation, even the most sterile sands may be rendered fertile, and it often happens that soils of this nature prove to be the best adapted for being converted into meadow land.

In process of time, irrigation communicates fertilising particles even to those soils which are most sterile and wholly devoid of nutritive matter, and this effect is produced more speedily in proportion as the water contains a greater quantity of these ameliorating substances, Where it is tolerably pure, and the amelioration is in consequence left solely to nature, it will be some time before the soil is materially improved.

The water, however, will cause the growth of lichens and mosses on the soil; which, as they putrefy, gradually produce some of that humus so necessary to the nutrition of other plants. Experience has testified that with the assistance of water, deprived of all foreign bodies, we may, in the space of ten years, create a thick turf even on the most barren sand; and, by continuing the irrigation, eventually transform it into fertile meadow land, which gradually becomes more and more luxuriant and rich. But this formation of turf and growth of grass will be materially accelerated if manure of some kind or other be bestowed on the land. Mould, or peaty substances, which may be obtained from the low country in the neighbourhood, will, even if slightly acid, prove beneficial; but there cannot be a doubt that the addition of a little manure will render them still more efficacious. Where cattle and sheep are fed on land thus converted into pasture, after it has been well drained, it will attain that state of perfection to which we wish to bring it much sooner than if the grass were mown as soon as it became high enough to be cut. But with the assistance of a plentiful amelioration of manure, the most sterile and arid sands may, in one year, be transformed into luxuriant pasturage, provided that they are well watered and sown with the seed of plants adapted to that kind of soil.

Land which is to be irrigated should be as even as possible, and have a gentle slope; the furrows which receive the water from the trenches ought to pass over the highest parts, in order that the whole of the surface may be watered. The drainage furrows should be formed in the lowest part, and be made to correspond with the irrigation furrows: by means of these the soil is drained, and the water conducted into some ditch or canal intended to carry it off; and, as has before been stated, in many cases these drainage furrows serve as irrigation furrows to some other portion of land lower down.

Sometimes the trenches for the purpose of irrigation are more or less parallel with those intended to carry off the water, while at others they form a greater or less angle. The furrows and trenches for irrigation ought to be parallel when the portion of land they are intended to water is perfectly even, and has an uniform slope commencing from the irrigation furrow.

I have already stated that the irrigating furrows ought never to exceed twenty perches in length; otherwise they are liable to become choked with grass. It will be understood that every one of them must have an opening into the irrigation trench: too many of these openings should not be made on the higher parts of the land when it can be avoided.

The surface over which the water is to be extended should never be too large; but it is quite impossible to lay down any rules for determining the size of it. When the declivity is very great, the space to be watered by a single irrigating trench must be narrow; otherwise the water will hollow out channels for itself, in which it will run, instead of spreading over the whole surface. Therefore, at the distance of about every ten or twenty perches, the water should be collected by means of a fresh trench, intended to spread it over some surface lower down, and this continued until it can be used no more.

When the land has little or no natural slope, or is uneven and full of hollows and falls, the furrows are so contrived as to form almost right angles with the trenches. The want of sufficient slope will prevent the water from running off as freely as it should do, and render it liable to settle on different parts of the soil; it is therefore necessary to have recourse to art in order to raise the middle of each division.

If the surface which we wish to free from water has natural elevations, irrigating furrows are formed on its heights, and drainage furrows in its hollows; and thus the latter are sometimes parallel with the irrigating trenches, and at others at right angles with them; or occasionally even oblique or curved: in fact, it is necessary to modify their form and direction according to the nature of the surface, if we would attain the end in view. When we wish to carry the water to the highest parts of the land, it often becomes necessary to make openings through the bank of the irrigation trench higher up than would otherwise have been expedient, and sometimes even to stop up the lower openings, in order thus to compel the water to flow back in the trench. The more even the surface which is to be irrigated, the less difficulty will there be in performing the operation; therefore, in forming a meadow, every endeavour should be made to level the soil as much as possible; and the best means of attaining this end is by additions of earth or mud brought to the land and deposited there by water, an operation which we shall presently have to describe more fully.

It frequently happens that when we impede the course of some stream or brook on the declivity of a hill, or at the foot of a mountain, we are enabled by means of a canal to conduct the water quite round this elevation, and retain it at an equal height in all parts. Where this can be effected, all that portion of land below the canal is within the power of the water, and, therefore, may without difficulty be irrigated. In order to be able to use all the water in the brook, and, nevertheless, irrigate and drain every part of the meadow in succession, this latter is best divided into six parts.

It frequently occurs, and especially when the soil which we are about to irrigate has but little declivity, that it is impossible to do without distinct furrows for carrying off the water which shall collect it from the upper portion of the meadow in order to convey it lower down, otherwise the whole of the land cannot be properly drained.

When the water has to pass across some low place in order to reach an elevated one, the canal must be raised throughout the whole extent, in order that the water may be retained at the level desired. If we then wish to irrigate the low grounds, openings may be made in the banks of the canal; but these latter must be neither broader nor deeper than is absolutely necessary to admit of the proper quantity of water passing through them; and as this water in falling may do mischief, or cause dilapidations, the openings we have just mentioned should be furnished with small sluices, and the water which passes through them received into channels lined with gravel.

There are districts in which a perfect system of cultivation is pursued, and this mode of irrigation applied to the most consistent and solid soils; there the water is taken from the trenches and thrown over wheat land with a shovel, and thus the plants are refreshed when they appear to require it: this mode of proceeding is usually practised in warm dry climates. The labourer stands in the centre of the trench, and from thence throws the water to the right and left as it flows towards him; all the ridges in the vicinity are thus equally and quickly watered.* It often happens that this kind of irrigation may be combined with inundation; but in order to effect this, it must be possible, by opening the irrigating canal and closing the tail-drain, to raise the water in the trenches to a sufficient height.

In watering land, it is frequently necessary to have recourse to machines similar to those employed in draining land. Among others, drawing wheels are employed, which are put in motion by the current of that water which is to irrigate the land. The water is then usually conveyed to the irrigating trench through pipes, and from thence emitted through openings into the furrows which are to extend it over the surface of the soil. However useful the inventions of this nature which are occasionally met with may be, the construction of and keeping them in repair is far more expensive than the establishment and maintenance of irrigations effected in the usual way; especially as the former, whatever may be their magnitude, will only suffice for a limited extent of surface. I am not certain whether the *ram* and other recent hydraulic inventions have as yet been made use of in irrigation. In England they have gone so far as to employ steam-engines for this purpose.

* See Simonde's "Agriculture of Tuscany," published at Geneva."

ON EARTHING AND WARPING.

In many countries, examples of this operation, which is often of such incalculable advantage, will be found. We are informed by Bernhard, that quantities of earth are thrown into the torrents which descend from the mountains, in order that it may be thus conveyed to the valleys and distributed over them, and thus raise the soil, or render it even. This operation is very common in Tuscany, where, according to Simonde, the author of the "Agriculture of Tuscany," extensive marshes are thus filled up, consolidated, and transformed into exceedingly fertile land.

But this operation has not been so extensively practised anywhere as in the sandy districts and furze lands of the Duchies of Luneburgh and Brême, where during the period at which these countries were in their most flourishing condition it became in a short time so general that every peasant who had it in his power to put it in practice did so without hesitation, and without being alarmed at the preliminary outlay which it required. This operation was facilitated in these districts by the formation of companies of speculative individuals, who journeyed from place to place, undertaking it for a remuneration proportionate to the extent of the soil and the difficulty of the operations. These men gradually became so skilful from practice as to require no levelling instruments save a rule and a plummet, yet they were almost always successful in their undertakings, and could estimate with the utmost precision the labour which each operation would occasion, and the difficulties which would present themselves during its progress.

The only person who has hitherto given a description of this operation is my friend J. F. Meyer, in his work entitled "Ueber die anlage der Bewaesserungswiesen, besonders derjenigen welche durch schwimmen hervorgebracht werden" ("On the formation of irrigable meadows, and especially of such as are formed by additions of earth conveyed to them and deposited by water"). This paper will be found in the "Agricultural Annals of Lower Saxony," year 2, part 3; but even this is not sufficiently plain and concise to give a clear idea of all the details of the operation.

Earthing consists in transporting earth from some elevation which overhangs a valley, to the low and frequently marshy soil of the valley; and effecting this by causing the earth to be conveyed in some stream emanating from a still more elevated point; in thus forming a uniform and gently inclined surface where the hollows and elevations formerly stood, which can always be properly irrigated. The more even the surface thus formed, and the greater its slope, the more thoroughly and perfectly can it be watered; and no degree of manual labour could produce the effect of the operation of earthing.

The direction which should be given to this amelioration, and the depth to which we should penetrate into the elevation, depends, firstly, on the slope which we have; secondly, on the quantity of earth which will be required to fill up and equalize the low ground, and form, both on the surface from which the earth has been taken and that to which it is to be conveyed, an even and slightly inclined plane, such an one as will facilitate irrigation and ensure its success. If we dig too far, there will not be room enough for the loosened earth; and, instead of its being deposited, it will choke the canal, causing the water to ebb back and destroying the slope. When, however, this operation has to be extended to a brook or river, as is usually the case, we can frequently get rid of the superabundant earth by causing it to pass into this river, and so be carried off by its current. But even where this can be done, it will be necessary to act with great circumspection; or considerable embankments will be washed up at some little distance below, and mill-streams and ponds be choked. Whenever there is the least danger of this, not a particle of earth should be suffered to enter the bed of the river; and in order to prevent it from doing so, a dam must be thrown up at the river side, or else a fence composed of stakes and twisted branches, which retains the earth while it suffers the water to pass through. But it will often be found to be better to fill up the original bed of the river, and substitute a canal cut in a right line. In this case a strong dam is thrown up in the river to prevent the earth from extending beyond the spot for which it was destined.

It is also of the utmost importance to ascertain, as nearly as possible, the quantity of earth which will be required to raise the low ground sufficiently.

In order to determine this point with the utmost possible exactitude, we must measure and calculate at every spot the height of the elevation we are about to level, and the hollows which we wish to fill up, in order to discover if they are proportioned to each other. But as the height, depth, and width change so frequently, it is scarcely possible to have recourse to actual measurements; and, therefore, we are forced to content ourselves with judging by the eye. Besides, it is often impossible to calculate the exact quantity of earth which will be deposited, because its component parts of clay and mud will be held in solution and carried on with the water, unless we can arrest the course of this fluid for a sufficient time to allow of these matters being deposited. In an operation of this nature performed upon a marly, argillàceous soil, the quantity of mud carried away by the water was so great that the banks of the stream were covered with it for more than a mile; and yet the declivity was very gentle, the water flowed on in an equal, uniform manner, was sufficiently extended to prevent its being too deep, and several dams were formed to arrest the progress of the mud. It is, therefore, evident that earth of this kind will not fill up and equalize low ground so much as it might be expected to do. Again, if the earth brought down by the water is deposited upon a spongy, marshy soil, as is frequently the case, the ground contracts so much under the pressure of the additional earth when dry, that hollows are made even where at first sight the soil appeared to be quite even. Lastly, in the mass of earth which has to be brought down by the water, a great many large stones will frequently be found, which must, of course, be got rid of; and these occasion a great diminution of the quantity of earth on which we had calculated. But whenever, during the progress of the operation, we perceive that there is not enough, or that there is too much earth to fill up a certain spot, we have a remedy. In the former case we can give an oblique and slightly retrograde direction to the strip of ground on which we are operating, and which otherwise ought to run perpendicular with the canal, and thus pass the earth on to those places where it is needed; while in the latter, on the other hand, we must give a contrary direction to the water; that is to say, we must give the strip of earth an oblique direction, but one which tends towards the points which have not been filled up. If, then, the section or profile of the elevation we are about to do away with, and the hollows which we intend filling up, are not equal, we must, where there is not earth enough, hollow the bed of the canal further into the elevation, in order to obtain a larger supply of earth; and where there is a superabundance of earth, we must change the direction of the canal and keep it outwards, so that there shall not be so much earth for the water to take up. The result of this must inevitably be, that the canal will not be straight, but run in a serpentine, sinuous direction, which should in general be avoided; but in this case it is scarcely possible to manage otherwise, and we must sacrifice the advantages resulting from the canal being in a direct line, in order to attain the end and intention of the operation, viz., the formation of a slightly inclined and perfectly even surface. When the earth is of a sandy nature, and inclined to divide, a superabundance of it is by no means objectionable. The operation is certainly attended with more labour, but then the extent of low ground raised and filled up is greater; and consequently the whole expense is proportionably less than it would otherwise have been. If we have sufficient water to carry the earth, and an extent of surface large enough to receive it, an elevation of upwards of twenty feet high may be levelled. It is only when the earth is tenacious and argillaceous, and must be raised by shovel-fuls and thrown into the water, that the operation becomes difficult and laborious. When the elevation is of a sandy nature, the earth will detach itself, sometimes even too easily, when the water rushes against it; and in this case it will be necessary to proceed with circumspection. The strip of ground on which we intend to operate, ought to be wide; and we should, as far as possible, avoid letting the principal current of the water pass too near the elevation of earth which it is our object to remove. The earth should first be loosened from the top and thrown into the current, care being taken to keep the slope of the elevation on the side next the stream quite even and not too rapid. The same must be observed with respect to the slope which is behind the canal; we must, in throwing down the earth, take care that it slides gently and does not obstruct the channel. It often eventually becomes necessary to form an extra mound or bank to the canal on the side next the eminence, in order that the water which falls into it after heavy rains or the melting of large falls of snow may not injure its sides. In this case, outlets or tunnels should be carefully and solidly formed, through which this water may drain off and run into the canal.

When the elevation which we wish to remove, in order to fill up the low ground and hollows beneath, is filled with the stumps of trees, it is not necessary to pull up these previous to undertaking the operation; for their roots being laid bare by the action of the water, soon become detached from the soil. Should it be deemed requisite, they may be dug round; and when this has been done, if the current of water is sufficiently strong, the whole stump, roots and all, will be carried down to the land beneath. The same may be observed with respect to stones of a moderate size, if the soil over which the water extends itself is sufficiently declivitous. It is only very large stones that need be rolled down or carried to some place where the ground has already been levelled. The labour of the operation is doubtless increased where these exist, but not to such an extent as it would be if we were obliged to dig into the soil in order to extract these stones, for here they are detached by the action of the water, without the intervention of any manual labour, and left upon the surface of the land; and in by far the greater number of cases, their value amply repays the additional labour they occasion.

When we come below the level of the eminence which we wish to remove, we have nothing more to do with the earth; the water deposits it much more equally, and renders the surface of the land much more even and uniform, than any manual labour possibly could have done. Occasionally, only, when the course of the stream is impeded or turned aside by some obstacle, or takes a wrong direction, this evil should be remedied by hurdles, which should always be kept at hand for the purpose.

The bed of the river is either prevented from being obstructed and left free and open to carry off the water by placing hurdles at its edge, or a new canal is formed for the river in the lowest part of the ground, and this defended by a straight hedge formed of stakes and twisted branches, in front of which the earth becomes amassed, and thus forms the bank of this canal. Its bed must subsequently be deepened and cleared.

But in by far the greater number of cases, and especially where the water and earth ought to be thrown on one side only, it will be better to commence by excavating a new drainage canal a little higher up than the river, and the bottom of which shall be deeper than the bed of the latter.

Care must always be taken that the upper portion of the piece of ground on which we operate shall be on a level with the bottom of the lateral trench which transmits the water to it from the head-main, because otherwise, in the irrigation which ought to supervene, we shall have some difficulty in extending the water in one uniform sheet over the whole surface of the soil. I have said the upper portion, because at the lower part the earth is deposited by the water in such a manner as to form an even, slightly inclined surface, highly favourable to irrigation. Where this point has been attended to, it will be sufficient to give an equal depth to all the openings made in the edge or bank of the lateral trench or secondary canal. It is by means of these openings, that the water is distributed into the furrows parallel with the canal, in order to be equally diffused over the whole extent of surface.

It is only in places where the lateral trench is of a considerable length, and where all the meadow has to be watered by one canal, although not at once, but in alternate portions or panes, that various waterfalls or weirs are formed; and not only the water in the trench lowered, but also the surface of the land which is to be irrigated. These falls are made of the depth of about half a foot at each division, and are regulated by small sluices formed in the irrigating canal. When one of these sluices is closed, the water rises in that part of the canal situated above it, and ebbs back and extends itself over the land at the side. If, on the contrary, the sluice is opened, the water falls into the next portion of the canal below, or the irrigating furrow below, and does not retain sufficient height to admit of its finding an issue through any of the lateral openings formed in the canal for the purpose of watering the land at the side. In this manner it extends itself over the second part of the land, or that which lies lower than the first, and is in the vicinity of the second part of the irrigating trench. In like manner the third, fourth, and all the other divisions are watered by turns. It will instantly be perceived how much trouble and labour is thus saved by alternately irrigating the several parts of the meadow, since all that need be done is to open or close certain sluices; whereas, under ordinary circumstances, it would have been necessary to open or stop up the openings one after another in the order in which we wished to water or drain each separate portion of the meadow.

As valleys formed or traversed by brooks are almost always hemmed in by two elevations, it is frequently difficult to determine whether, in endeavouring to fill up the hollow and equalize the surface, we should take the earth from both sides, or from one only. Locality and contingent circumstances can alone decide this question. All we can do is to lay down a few general rules for guidance. The following are the principal considerations which must determine our decision :—

(*a*). Is there a sufficient quantity of water to enable us to irrigate both sides consecutively, even during the driest seasons?

(*b*). Is the width of the valley from either side to the middle of the low ground sufficiently great to admit of the ameliorated surface repaying the expenses of the operation?

(*c*). Or is the valley of such an extent only as will allow of our being able to extend the earthing over it from one side?

(*d*). Is the soil on both sides equally proper for the performance of this operation. When the operation has to be undertaken from both sides of the valley, two separate canals must be directed over the two elevations; or, if only one canal is formed, branches must be made, each provided with a sluice, in order that the water may be made to flow from one side or the other, as seems best. One drainage canal is usually all that is required for carrying off the water, and this may be made to pass through the middle or lowest part of the valley. When the operation is to be performed from but one side of the valley, the drainage canal is excavated on the opposite side, and at as great a distance as possible, and so contrived as to ensure the edge of it being lower than the lowest part of the land to be operated on.

When an immense extent of ground is to be operated on, it is not always requisite or possible to earth every part of it. Some portions will be found which naturally present that even and inclined surface which is so indispensable to the success of irrigation. These will only require to be connected with the others by means of a dyke or tunnel, and also with the drainage canal, in order that the level may be preserved.

On the other hand, we sometimes meet with eminences which cannot be removed, either on account of the nature of the soil of which they are composed rendering it a difficult task, or because we should not know what to do with the earth taken from them. Where this is the case, the canal must be dug across the elevation, and excavated to a proper depth; or should the elevation be too high to admit of this, it may be conducted circularly round it.

The labour and expense attending this operation can neither be calculated according to any general average, nor by inference; so much depends upon locality. The formation of some meadows made in this way has not cost more than five rix-dollars per acre, while others have cost fifty rix-dollars per acre. This variation is chiefly occasioned by the following circumstances:—

(*a*). If the river from which we get the water be of a considerable size and width, the expense attending the making of the principal sluice will be very great. This sluice is, however, equally as necessary for ten as for a hundred acres of ground; and, therefore, it may easily be conceived that the result will be rather different when the expense has to be divided among the latter number, to what it would have been when divided among the ten acres.

(*b*). The same may be observed with regard to the principal canal or headmain, which frequently has to pass for some distance over a considerable elevation, whereby its formation is rendered very expensive.

(*c*). The quantity of water which we have at our disposal, and the rapidity or gentleness of the slope, have likewise considerable influence on the difference of expense. The more water or slope we have, the less laborious and expensive will be the operation.

In general, at the commencement of this operation of *earthing*, there is but little slope, and, consequently, more hands are required to ensure the earth being properly mixed with the water and carried down by it; but as the operation progresses, the slope is increased between the lateral canal which brings the water, and that through which it is drained off, the bed of the brook always having some fall; thus the operation becomes less laborious, and the water acts more by its own propellent force: we can then penetrate further into the elevation, and carry the earthing over a larger extent of ground. The first portion is always the most expensive.

(*d*). The nature of the soil likewise makes a very considerable difference in the expense; where the soil is of a sandy nature, not one-third of the manual labour need be employed which is requisite on argillaceous land.

(*e*). The expense will also be less per acre in proportion as the hollows which we wish to fill up are large when compared with the elevations that are to be levelled; for the labour is confined almost entirely to these latter. The *earthing*, or, in other words, the washing down and distributing of the earth will always be best effected by the action of the water alone, or at least with very little assistance. This operation may be extended from one side over a width of forty perches: provided that there is the requisite degree of slope, the earth will be transported and deposited perfectly well to that distance. If, therefore, I wish to do away with an elevation of ten perches in height, and fill up a hollow or valley of thirty perches in width in one place, and a hollow of only six perches in width in another, the extent on which I operate in the latter case will cost me very nearly double what it would in the former.

(*f*). The skill and activity of the workmen will likewise make some difference. When these men are accustomed to the mode of doing the work, and when the head labourer or overseer, who directs and superintends the whole operation, and especially every part connected with the lateral canal, and the upper portion of the surface on which the water acts: when this man is clever and understands what he is about, the amount of labour will be sensibly diminished without any part being rendered heavier, and many errors avoided, the repairing of which would have been productive of both trouble and expense.

This last circumstance is of so much importance that the companies of men who get their living by undertaking this operation in the Duchies of Luneburgh and Brêne, execute it for much less than it could be performed by labourers hired at the lowest wages, even if the farmer superintended and assisted himself. After taking a cursory survey of the ground, these men state at once how much they shall charge for the performance of the operation, and how long they shall be about it, so skilled are they in all relating to this point. When the agreement is made at so much per acre, the sum asked is generally from eight to twenty rix-dollars; that is, supposing the soil to be light and sandy, or at any rate to contain a considerable proportion of sand.

I have undertaken the formation of a meadow of this kind here under the most unfavourable circumstances, and with the assistance of labourers who were previously wholly unacquainted with the operation; up to the present time it has cost me five hundred rix-dollars, and twenty-eight acres are actually completed. Not one of my labourers had ever seen or heard of the operation before, and I was practically unacquainted with all its details, and was, therefore, compelled to study, practise, and often guess at the proper way of setting to work.

For the first few years an establishment of this nature is always requiring some repairs: either the canals give way from their banks and sides being washed down by floods arising from heavy rains, large thaws, &c.; or else it becomes necessary to enlarge, or alter, or strengthen the openings into the irrigation trenches and furrows, or alterations are required for the purpose of being able to effect the drainage of certain low marshy spots, or filling up these places with earth. But afterwards, when every part is properly arranged and has acquired solidity, the expense of keeping in order a meadow watered in this manner is less than that of any other, on account of that uniformity of surface which renders a smaller number of furrows necessary; and also on account of the gentleness of the slope: in fact, the expense may be said on an average never to exceed six groschen per acre. I have not included in this calculation the principal sluice which must be renewed every twenty years.

A meadow thus formed is a great while before it yields a good crop of grass, especially on the upper part, if left to the action of nature alone, and no attempt made to assist her operations.

Where this is the case, it must not be irrigated during the first few years, or, at least, only with the utmost circumspection, otherwise the water will wash the earth from the naked soil, and form channels in it. All we can expect from such dead ground is a few plants which are indigenous, as perhaps the gray hair-grass (*aira canescens*). When vegetation does begin to appear, it is usually in the following order: mosses, lichens, and a few other similar plants are first formed; and the more completely such a meadow is covered with moss at first, the better will it be for it ultimately. When the continuous irrigations intended to earth the land have ceased, and the soil is alternately irrigated and drained, the moss perishes, resolves into mould, and thus serves to nourish the other plants which then spring up. As the grass thickens, the moss disappears, even when no means have been taken for encouraging the growth of grass, excepting that of bestowing frequent irrigations on the meadow; at least, as frequent as they could be without incurring the danger of washing away or channelling the ground. In general, about the fifth year after the operation, a crop of hay may be obtained which is worth the trouble of getting in; and ten years afterwards we may anticipate from a sandy soil a crop yielding twenty quintals per acre. But the growth and vegetation of grass will be expedited by pasturing sheep on the land as soon as it is solid enough to bear the pressure of their feet, and begins to produce a little grass: this plan is much better than mowing, especially if care is taken that the land shall be thoroughly drained in the first place.

The fertility and productive properties of the land will, however, be called into action much sooner and more effectually if some portion of manure can be bestowed upon it. Every kind of fertilizing matter which is generally bestowed on meadow land will prove beneficial here; and folding sheep on the ground for a short time will be particularly advantageous to it. I know a case in which the folding of geese on a meadow thus formed was productive of benefit. But nature in general furnishes us with matter, as mould, peat, and the layer of turf, which is found in the hollows. After the drainage canal has been excavated, these matters should be raised with a spade from the places where they are thickest and most plentiful, and conveyed to the upper parts of the ameliorated surface, there to be made into heaps, and, if practicable, mixed with animal dung, lime, or ashes. After the lapse of a short time, these heaps will be ready to be spread over the newly earthed soil. Where this amelioration has been bestowed, a tolerably good crop may be anticipated, even as early as the second year. There is not the least doubt but that if we sow land thus ameliorated with grass seeds, we shall expedite the period when it will produce an abundant crop. But great care must be taken in the selection of the kinds of seed and their proportions. Those plants which shoot up most vigorously during the period in which the meadow ought not to be watered, perish as soon as the irrigations are recommenced. On a soil composed of marly clay I sowed red clover, tall oat-grass (*avena elatior*), tall fescue grass (*festuca elatior*), meadow catstail grass (*phleum pratense*), round-headed cock's-foot grass (*dactyle glomerata*), meadow soft or woolly grass (*holcus lanatus*); and on the lower parts of the ground meadow fox-tail grass (*alopecurus pratensis*). These plants shot up and throve wonderfully during the first year, or that succeeding to their being sown; on the second year they were weaker and poorer; and at the end of four years they had totally disappeared, and given place to others. The vegetation of those parts which had been left to nature now seemed to surpass that of the places where the above-mentioned grasses were sown. The most remarkable fact is, that of all these plants that which stood its ground best, notwithstanding the plentiful irrigations bestowed on the soil, was the red clover, which even forced its way through the moss. I should not, therefore, advise any one whose views extend beyond the few first years to sow their land with such vigorous plants, but rather to abandon the production of herbage on it to the action of nature, unless they can select such grasses as experience teaches us are likely to produce the most plentiful and luxuriant crop on land which has thus been formed into a level surface by the operation of earthing. It may seem inconceivable, but daily experience convinces us of the fact, that those very plants spring up naturally on irrigated meadows that have not been sown at all which are best adapted to the nature of the soil, and most likely to be benefited by irrigation. Many of those grasses which would yield but a scanty crop of hay, if grown on land that was never watered, will, when springing up on irrigated meadows, yield a luxuriant crop. Where neither manure or mould is spread over the surface of the soil, there is no doubt but that it is a long time before a perfect layer of grass is formed; but if the soil is ameliorated, it shoots up much sooner, and so luxuriantly as to render it inconceivable whence this quantity of seed and germs can have come.

It is, however, essential to give consistency to the surface of the soil, in order that it may throw off the water, and I have found nothing answer this purpose so well as *spurry*. When the meadow has been *earthed* in the beginning of the summer, spurry should be sown at the latter end of that season during wet weather, and grass seeds may be intermingled with it. As soon as this plant rises above the surface of the ground, it gives a degree of consistence to the soil which renders it capable of bearing irrigation. It never comes to maturity, because the frosts kill it, and then it rots in the ground. But when the ground is hard and solid, cattle may be pastured on the spurry, which not only increases the consistence of the soil, but also manures it, and causes it on the following year to bear a luxuriant crop of herbage, especially if a little manure is also spread over it.

Persons who have never experimented on meadows of this kind, can scarcely form an idea of the wonderful fertility which may be produced even on the poorest sand. But we have such undoubted proofs of the fact, as place it beyond all shadow of uncertainty. The more sandy or gravelly a soil is, the better is it adapted for being formed into these kinds of meadows, provided that it is subsequently practicable to irrigate them thoroughly. They may be constantly and frequently watered, without any danger of their becoming marshy; and the water deposits its most fertilizing particles on the surface, while the residue sinks down into the ground. As soon as we stop the irrigation, the land dries; and when we recommence watering it, it speedily becomes impregnated. All that is requisite to ensure the vegetation of grass is moisture, warmth, and mould; the nature of the soil is a matter of secondary importance, provided that it is plentifully supplied with water. The injurious dryness of sand is counteracted where the soil can be irrigated whenever it appears necessary, and the layer formed on it by the turf and the tissue woven by the roots of the plants serve to give it consistence.

There can be no doubt that land which has undergone the operation of earthing, especially when once a layer of rich turf and mould is formed on it, can be ploughed and made to bear any of those crops which during dry weather are benefited by irrigation; whereas, if the soil was of a barren sandy nature, no durable profit could be derived from such a course of proceeding, because the ploughing would at once destroy the turf or sward, and render the land loose and friable. I have known persons who, seeing that irrigation had produced a great deal of moss on soils which had received no manure, have had recourse to ploughing in order to destroy that moss, and deemed such a proceeding absolutely necessary. But here the moss is one of nature's admirable provisions; it disappears of its own accord as soon as the grass finds sufficient nourishment for its support in the mould which has been formed on the surface of the soil, and as soon as the irrigations become more moderate. Besides, the best and quickest way of destroying it would certainly be to manure the soil, as this would promote the vegetation of the grass at the same time.

Earthing somewhat resembles an operation occasionally practised in England, and which is termed *warping*. This, however, can only be performed where there is a regular stream or water-course which washes up mud and falls into some larger river or stream, and where, at the side of the former, or else at a greater or less distance from it, there is a piece of land below its level, which the water may be made to flood. By means of a sluice opened for the purpose, this muddy water is made to overflow the land which we intend to warp, and is retained on it until all the mud is deposited. By means of another sluice which is afterwards opened, the clear water is carried off. When the ground has become tolerably dry, the muddy water is again made to overflow it, and again let off after leaving its deposit, and this mode of proceeding is continued throughout one or two whole summers. I knew a case in which a layer of muddy earth eighteen inches thick was thus deposited over a barren sandy soil in the course of a single summer, by which means all the hollows were filled up, the asperities softened down, and the soil rendered peculiarly fertile. Not very long ago, 212 English acres of marshy land in Lincolnshire were covered with a layer of mud varying in depth from eighteen to forty-two inches, according to the elevation or hollows on the surface of the soil. This may be compared with those operations of a similar nature performed in Tuscany, of which we have already spoken.*

ON THE MANAGEMENT OF MEADOW LAND.

By the term "meadows" I mean to signify portions of land covered with a sward composed of various plants or kinds of grasses, and which are generally mown for the

* In Bollonais and Romagna this operation is frequently had recourse to. I have myself performed it very successfully in the latter place, and will endeavour to give such an account of it as will give a clear idea of its details. Those rivers which flow from the western part of the mountains and hills of the Appenines, are all of them charged with more or less mud. A canal which derived its water from Santerno, and was sufficiently above the town of Imola, had been formed for the purpose of furnishing a supply of water to a row of mills. This canal crossed my farm, and furnished the land with water when required for irrigation, for the cultivation of rice, &c.

After heavy rains, the water which washed the vineyards and partially manured sides of the hills, precipitated itself into this canal, carrying with it such rich mud, that frequently twelve ounces of water taken from opposite my farm would yield an ounce of mud. The canal belonging to the mills was at this point raised ten or twelve feet above the level of the soil. Floodgates which could be opened at will supplied those lands which had a right to it with the requisite quantity of water.

When I wished to deposit this mud over a certain extent of ground, I constructed an irrigation canal above the level of the soil for the purpose of receiving water from the principal canal and carrying it on to those portions of land which I intended to warp. Along the side of this secondary canal, I marked out small squares of land, each about an acre in extent, which communicated with this canal by means of small sluices or openings, and with the drainage canal by other sluices or outlets. When I wished to commence the operation, I let the water on to one of these squares, and suffered it to rise to the height of from a foot to a foot and a-half. If I wished the deposit to be light and friable, I did not suffer the water to remain there long, but drained it off quickly; while, on the other hand, if I wished to obtain a more argillaceous deposit, I retained the water there until it had parted with all its clayey particles, which, being light, would otherwise have been carried off into the drainage canal. As fast as one square was drained, I let the water on to another; and so on, until all had been submitted to the operation. When the squares are of a moderate size, the mud will be uniformly deposited and the surface rendered very even; but when they are very large, the deposit will be amassed near the openings through which the water flows on to the soil, while the more distant parts will be left almost bare. In order that the water might lose as little mud during its course as could be, the secondary canal was made perfectly straight and even, and capable of containing a sufficient volume of water to render the current tolerably rapid.

In this way I was often able, in the course of one year, to raise the layer of vegetable soil on a considerable extent of ground, from seven to eight inches or more; and the part which was thus added, being free from stones or gravel, formed a soil which, when drained and slightly manured, was favourable to almost every kind of produce, and which could be tilled with little labour. There are few agricultural operations which are productive of such real and permanent benefit.—French Trans.

purpose of bearing hay crops. There are two classes of meadows: natural and artificial. Some persons term ploughed fields which are sown with clover, lucerne, and sainfoin, for one or two years, artificial meadows; but I do not consider that they can be classed under the head of meadows at all. Neither do I rank under this head fields which are sown with different grasses, or with various kinds of plants, but which are not intended to be left in this state, and which are not covered with a thick layer or sward of these plants—a circumstance which rarely occurs in dry places where grass which is to be mown has been sown, or where the crop actually has been cut; because such herbage perishes after the lapse of a few years, and gives place to plants of an inferior kind. The kind of ground most proper for meadow land is that which is naturally too damp to admit of its being ploughed. A portion of land cannot be rendered fit for an artificial meadow, until, by some operation of nature or art, that degree of moisture which is requisite to ensure the growth of the grasses has been communicated to it, and can be maintained. We have already spoken of artificial meadows when treating of irrigation.

Natural meadows are always much more humid than arable land, or are situated in damper situations. They are divided into the following five principal varieties:—

1. Meadows situated on the banks of large rivers, which have either been formed by earthing, or, in a great measure, by the decomposition of aquatic plants thrown up by the water. Sometimes they occupy large valleys, and are under the influence of water-courses, which from time to time inundate and cover them with a fertilizing mud, or which saturate and perforate the sub-stratum, and thus communicate to them the requisite degree of fertility.

2. Those which are on the banks of smaller rivers or brooks from which they derive their humidity, and by which they are occasionally watered, either through the overflowing of the stream, or by means of artificial

establishments which impede the current of the water and diffuse it over the land in the form of inundation or irrigation.

These two first varieties are known by the name of *low meadows*, because they are only found in valleys or low grounds near to the beds of rivers.

3. Meadows which are situated either on eminences, or on the sloping sides or in the hollows of valleys, and which receive depositions of water which drains away from the higher ground or arable land above their level, which water often bears with it various sorts of animal matter and manure. Exceedingly fertile meadows are often found at the foot of high mountains; these receive a portion of that abundance of water which the mountains derive from the atmosphere.

4. Those meadows, the soil of which contains springs, and in which the water filtrates through the soil, shows itself upon the surface, and forms damp places, which render the land unfit for being ploughed.

5. Marshy meadows, which are formed in a similar manner, and are raised by the decomposition and putrefaction of aquatic plants which the soil had produced. These meadows are always of a spongy nature.

The soil of meadow land varies according to its position and situation. That of meadows of the first kind is either argillaceous and impregnated with a great deal of humus, or is chiefly composed of humus. When this latter species of soil does not contain too great a degree of humidity, and is not of a marshy nature, the humus contained in it is usually mild and soluble; but where the soil is humid and marshy, the meadows assimilate more to those of the fifth variety in the nature of their products, as well as in the nature of the soil.

Meadows of the second class are usually composed of soil more inclining towards sandy, and are less rich in humus, at least to a certain depth. But when this kind of land is well furnished with plants, covered with grass, and properly watered, the greater or less degree of richness in the earth below the roots of the plants is a matter of comparatively slight importance; and where a proper degree of moisture can be maintained, a permeable sandy soil is often better than a compact argillaceous one.

Meadows of the third class are usually composed of a soil analogous to that of which the hills by which they are surrounded are composed, and their fertility is generally proportionate to that of those hills. When water charged with fertilizing particles falls from the hills to these meadows, they frequently yield a wonderful amount of produce, especially if they are well watered and their soil is sufficiently permeable to admit of the moisture draining away. That celebrated meadow in Wiltshire, which I had occasion to speak of in the third volume of my "English Agriculture," and the fertility of which would appear scarcely credible if it were not attested by eye-witnesses for this century past, is one of this class. But when this variety of meadows is found situated between portions of poor arable land, from which it only obtains scanty emanations during wet weather, or else receives such a superabundance of water as renders them marshy, causes it to produce aquatic plants, and prevents it from being tilled, while in dry weather, on the other hand, they suffer drought, they are of little value, yield but a scanty produce, besides being in every way inconvenient from being intermixed with arable land. These considerations have frequently determined enterprising farmers on turning off or finding a drainage for the water, on earthing the land and drying it completely, and transforming it into arable land. Where the position of the meadows renders it worth while, and where their humidity is uniform, moderate, and durable, it will be highly beneficial to manure them, when their subsequent produce will thus often be doubled.

When, in meadows of the fourth variety, or those which are generally found situated at the foot of mountains and hills, the water flows over the surface of the soil without stagnating on any part, they are often exceedingly fertile and covered with thick grass, the fibres of which are fine, and the flavour sweet; this is especially the case when the water is slightly calcareous or gypseous. But if, on the other hand, the water, instead of extending over the whole surface, sinks into the substratum and there remains, rank grass springs up, containing but little nourishment and composed chiefly of reeds, rushes, and other marshy or aquatic plants. Such land may, however, be very frequently transformed into very fertile irrigated meadow land by being perfectly drained and freed from all its stagnant moisture.

Meadows of the fifth class are not always absolutely unprofitable. When, by the accumulation of successive layers of dead plants they are raised sufficiently to give to the water such a degree of drainage as to prevent the land from becoming too much impregnated with it, the humus will become mild, and soluble, and fertilizing; and an abundance of rich grass will be produced, even though the substratum of the soil be so spongy and full of water that recourse is obliged to be had to extraordinary modes of carrying the hay, as, for example, waggons having very broad wheels. But when the meadows are not thus favourably situated, and are too damp, they produce anything but marshy plants, wholly devoid of nutriment, brackish, and often unwholesome; a kind of herbage which nothing but scarcity of fodder, or absolute necessity, induces the farmers to make use of.

Meadows are characterized by the denomination of acid or sour meadows. The water which collects in the ditches is often covered with a scum of various shades, and it deposits a red-brown ochreous matter, which usually contains phosphate of iron. If we dig deeply, we come to portions of marsh-iron in a more or less hardened and stony state; and, in all probability, the ochreous matter brought to the surface of the soil by water arises from these. Marshy meadows on which this kind of standing water is found yield very bad fodder, especially if we do not endeavour, by digging drains, to carry off this acid and ferruginous matter from the surface of the soil. When not rendered damp by this injurious moisture, they are exceedingly fertile, and some of the very best we have.

Such meadow land may be exceedingly ameliorated by being drained, especially if we are able to turn the water again upon the soil in the form of an irrigation if we think fit, they are likewise benefited by an addition of earth procured from elsewhere and spread over them.

In meadows of the first and second class, we must always pay particular attention to their solidity and safety from inundation; for, however favourable to them an influx of water may be during winter, or in the spring before the commencement of vegetation, it is in the highest degree injurious if it occurs when the grass is in full luxuriance or about hay-making time; as also is it when in the spring the water remains so long on the surface of the soil as to destroy and putrefy the herbage. But this point depends, in a great measure, upon the nature of the rivers which the meadows adjoin. We have already pointed out the means of remedying this evil while speaking of draining.

The value of meadow land depends partly on the quantity and partly on the quality of its produce. In general, if the humus contained in the soil of which they are composed is mild, this quantity and quality will be found to be proportionate. When a meadow yields an abundance of hay, it is usually found to be composed of good plants; and in proportion as its fertility is increased either naturally or by ameliorations of manure, will the good grass choke and destroy the bad. The only exception to this rule is in the case of marshy meadows full of acid humus, which frequently yield an immense crop of luxuriant but rank, unwholesome grass. It too often happens that in very good meadow land some kinds of unwholesome grasses become engendered, which deteriorate the goodness and value of the hay.

The nature of the soil of meadow land is not a point of so much importance as the nature of the soil of arable land would be. If the meadows are only properly moist, and contain a sufficient proportion of mild, soluble humus, it is in many respects a matter of indifference whether the soil is of an argillaceous or clayey nature. I mention the above conditions because when they are wanting, an argillaceous soil will always be preferable; whereas, when there is too much humidity, a sandy soil will always be most advantageous. Where the soil possesses a sufficient and suitable degree of humidity, it is not necessary that it should be impregnated with humus to any great depth, because grass derives the chief part of its nutriment from the surface of the ground, and its roots rarely penetrate further than to a depth of four inches. In dry meadows, on the other hand, a deep, fertile soil undoubtedly contributes most to the abundance and luxuriance of the herbage, by retaining moisture for a longer period.

The best meadow grasses, those the reproduction of which is most favoured by the fertile meadow lands, and which, by the rapidity and luxuriance of their growth, afford the most ample testimony of the goodness of the soil, are the following:—

Meadow fox-tail grass (*alopecurus pratensis*), smooth-stalked meadow grass (*poa pretensis*), rough-stalked meadow grass (*poa trivialis*). An abundance of these three varieties is a certain sign of great fertility.

Annual meadow grass (*poa annua*), reed meadow grass (*poa aquatica*). This is the best of all grasses for damp places, notwithstanding its resemblance to reeds.

Tall fescue grass (*festuca elatior*), floating fescue grass (*festuca fluitans*), rough-headed cock's-foot grass (*dactylis glomerata*), crested dog's-tail grass (*cynosurus cristatus*), meadow cat's-tail grass (*phleum pratense*), yellow oat grass (*avena flavescens*), tall oat grass (*avena elatior*), red clover (*trifolium pratense*), creeping white clover (*trifolium repens*), various kinds of trefoil, and especially the common bird's-foot trefoil (*lotus corniculatus*), meadow vetchling (*lathyrus pratensis*), tufted vetch (*vicia cracca*), black medick (*medicado lupulina*), hop trefoil (*trifolium procumbens*), yarrow (*achilea mille-folium*), common carraway (*carum carvi*).

The last-named plant is, however, generally destroyed in meadow land, because pigs are so fond of it that it is impossible to prevent them from breaking into and injuring the meadows where it grows.

The following do not yield so large an amount of produce; but must, nevertheless, be classed among the good meadow grasses:—

Perennial ray grass (*lolium perenne*), common quaking grass (*briza media*), meadow, or soft woolley grass (*holcus lanatus*), sweet-scented spring grass (*anthoscantum odoratum*).

The last two are not, in my opinion, so good as they are generally considered to be.

Sheep's fescue grass (*festuca ovina*), hard fescue grass (*festuca duriuscula*), downy oat grass (*avena pubescens*), brown bent grass (*agrostis canina*), knee-jointed fox-tail grass (*alopecurus geniculatus*), meadow oat grass (*avena pratensis*), bulbous stalked cat's-tail grass (*phleum nodosum*), blue flowering hair-grass (*aira cærulea*), soft brome grass (*bromis mollis*).

These only grow on marshy meadows, of which they often form the chief produce. Various kinds of clover must also be ranked here.

Common cow parsley (*chærophylum sylvestre*), cowslip (*primula veris*), scabious (*scabiosa*), burnet and small burnet saxifrage (*poterium sanguisorba officinalis et pimpinella saxifraga*), gentian (*gentiana centaureum*), common brunella (*brunella vulgaris*), common marjorum (*origanum vulgare*), wild thyme (*thymus serpillum*), rib grass, common and large (*plantago lanceolata media et major*).

The plants generally indigenous to bad meadow land or such as is of a doubtful quality are the following:—

The various kinds of horse-tail (*equisetum*) which do not form good pasturage for cattle, but are well adapted to horses and sheep when the ground on which they grow is dry. The best of all these is the river-horse-tail (*equisetum fluviatile*), which is very palatable to horses, and forms excellent food for them both in a green and a dry state.

The various kinds of crow-foot. All these grasses are in their nature acid; but some of them lose this property when dried. The creeping crow-foot is the sweetest, and this grows spontaneously in meadows.

Yellow cocks'-comb (*rhinantus crista-galli*). When this plant is young and in flower, it forms a very good sweet fodder; but at the time when the hay is usually mowed it has lost all its succulency, and become so dry as to resemble straw when mixed with the hay. This plant sheds its seed very early in the year, which causes it to multiply with great rapidity. The best way of destroying it is to cause it to be eaten off the land by the cattle in the spring.

Common marsh marigold (*caltha palustris*) is also agreeable to cattle when given to them while young, and it decks the meadows with its brilliant yellow colour; but when it grows older it becomes disagreeable to animals.

The various kinds of docks (*rumices*), and especially of sorrel, frequently occupy the greater part of land in high dry meadows. When mown while young, they yield a tolerably abundant crop of fodder. Nevertheless, they rank among some of the worst meadow grasses. The different varieties of colt's-foot (*tussilago*), which with their large leaves choke up plants, yield but a scanty nourishment to cattle.

Spotted persicaria (*polygonum persicaria*) is eaten by cattle while young and tender, but deteriorates from the value and goodness of hay with which it is mingled.

Common tansey (*tanacetum vulgare*) is a plant which has a large root, possessed of great medicinal virtues in some diseases of horses and sheep, but which yields fodder of a very disagreeable flavour. It is seldom found excepting on the highest edges of meadow land.

Common water-drop wort (*œnanthe fistulosa*) is propagated very rapidly in damp situations; but cattle do not willingly eat it. The same may be observed with respect to hemp agrimony (*cupatorium cannabinum*).

Corn mint (*mentha arvensis*) has a very injurious influence on the milk of cattle eating it.

Lady's mantle (*alchemilla*), both the long and the round-leaved varieties cover the soil with their leaves, and their juices are suspected to be of an acid nature. The same observation may be applied to the mouse-ear (*hieracium pilosella*), which is disagreeable to cattle, and imparts an unpleasant flavour to their milk.

Lastly, all the sedges and rushes (*carices et junci*) belong to the list of bad meadow grasses. Every care should therefore be taken to free the soil from the above-mentioned plants, which may be effected by preventing them from attaining maturity and shedding their seeds, and by manuring the soil.

Similar objections may be urged against the varieties of mosses and lichens.

The following plants are actually poisonous, and, consequently, in most cases are exceedingly injurious to the pastures on which they grow, rendering the whole crop unwholesome :—

Common henbane (*hyoscyamus niger*), thorn apple officinal (*datura stramonium*), water cowbane (*cicuta aquatica*), water hemlock (*phellandrium aquaticum*), strong-scented lettuce (*lactuca virosa*), broad-leaved water parsnip (*sium latifolium*), common fool's parsley (*æthusa cynapium*), spurge (*euphorbia*), the various kinds of anemone or wind-flower (*anemone*), common meadow saffron (*colchicum autumnale*).

Every endeavour should be made to destroy and extirpate these plants; and in order to effect this they should be torn up from the meadows whenever they appear. The goodness of a great number of our meadow grasses, and their adaptation as food for various kinds of cattle, both in a green and a dry state, is a point which merits the strictest examination.

Hasselgreen has certainly furnished us with an account of the experiments made by the pupils of Linnæus with different grasses on cattle, sheep, goats, pigs, and horses, with the view of discovering how far they were agreeable to the palate and adapted for the nourishment of these animals. But this account contains so many false statements that we scarcely dare give credence to any.

Among other things he states that corn spurrey (*spergula arvensis*) is rejected by cattle; whereas there is no plant which they eat with such avidity and pleasure.

The plants of the first class, with many others—for I have only mentioned those which are most frequently met with and are most remarkable—form a layer or crust of turf or sward with the tissue of their roots. This crust is composed both of living and dead roots, and of the mould resulting from the decomposition of the latter. A thick layer or sward of this nature is not easily obtained from pasturage composed either of one or many kinds of grass artificially sown. In order to produce it, the plants must not only be such as agree with one another, but they must likewise be sown in suitable reciprocal proportions; and these proportions, as well as the selection of plants, must be in accordance with the nature of the soil and its properties. Consequently, it often happens that when we sow grass seeds, we obtain fields of grass, but not meadows properly so called. We obtain high, but not durable and closely grown grass, and never an actual sward or turf; and very frequently the plants which have thus been sown, totally disappear and give place to others. Even when fields thus sown with the choicest variety of grasses, after the crust of their natural herbage had been broken up by ploughing, have, during the first few years, yielded a product far surpassing that obtained from natural meadows, the soil of which was of a similar quality. This luxuriance has not lasted long, but has diminished, until at length the land yielded less than even the poorest meadow ground.

But if, when sowing grasses to form a meadow, we are enabled to ascertain the exact and proper proportion of each variety, both as regards each other and the nature of the soil, there is no doubt but that we shall obtain this sward or layer of turf much sooner than if we left the soil to the operation of nature only. But there is very great difficulty in determining the ratio of this proportion. The most important point is to mingle a proper quantity of long and short, of early and late grasses, the former of which yield the first crop or cutting, in conjunction with the latter, which also yield a second crop or after-grass. Some farmers, who have ascertained or guessed at this proportion, have succeeded in forming good meadow land; while others, who have been less fortunate, have obtained such poor pasturage that they soon ploughed the ground up in order to sow it with other and more profitable crops.

From what I have seen, I have been led to consider that the mode of proceeding which I am about to describe is the one best calculated to obtain a good collection of grass seeds. I must not be understood to confound meadow land with those fields which are sown with herbage, and which are only intended to remain in that state for a limited period. Some spot is chosen in a meadow, the soil of which is similar to that of the one which we wish to form, especially as regards the proportion of humus contained in it, and its degree of humidity; some spot, I say, is chosen which yields particularly fine herbage; every care is taken to free it from weeds, and it is reserved for the production of seed, its fertility being maintained by ameliorations of manure. The grass is suffered to grow until the seeds of the early varieties begin to ripen; it is then mowed and dried for the purpose of being made into hay, care being taken to move it about as little as possible. Another portion is allowed to grow until the seeds of the later grasses have attained their maturity, and then it is cut down and dried in a similar manner. These two portions of dried grasses are then mixed together and threshed on the barn floor, and the dust and seed swept up, and sown on the soil of the ground which we are about to form into a meadow. This mode of proceeding appears to me to be not only the most certain but the least expensive way of obtaining a proper mixture of good grass seed fit for the formation of durable meadows, as, here nothing is wasted, because the hay from which the seed has been threshed, although undoubtedly not so good as it would have been had its vegetation been less prolonged, may still always be used. If the soil of the new meadow is adapted for the production of red clover, it will in general be advisable to mix some of the seed of this plant among that which we are about to sow, because it does not fail until about the second or third year, at which period the other plants have not acquired their luxuriance; but we must always make it a rule to mow the clover as soon as it begins to flower, and not allow it to complete its vegetation, or it will injure the other plants which do not grow so rapidly. When this point is attended to, it will retard the growth of the other plants but little, and they will shoot up and occupy the vacant space left as soon as it is mown.

Some close and attentive observers have pretended to perceive a kind of rotation among the various grasses with which meadow land is covered; that is to say, they assert that after a certain number of years those grasses which were previously most numerous are no longer found, but in their stead others, which, in their turn, again give place to fresh varieties. This may have arisen from various causes which escaped the notice of these persons; nevertheless, this assertion ought to be further inquired into.

The quantity of hay grown on any particular spot being generally proportionate to its quality, when no bad or injurious weed is mixed with the herbage, we can almost always determine the value of meadow land by reference to the quantity of hay which it produces. It is equally difficult to arrange the various qualities of meadow land under heads or classes as it is to arrange arable land in a similar way, because there are so many gradations or shades of quality that it is almost impossible to define where one class ends and another begins. It is, however, quite sufficient for our purpose, and agreeable to our classification of arable land under six heads, to divide meadows into a like number of classes, taking as the ground work of this division chiefly the quantity of hay yielded by them, and in the lower classes being slightly influenced by the quality as well. The following are the divisions:—

First class. Meadows which yield at two cuttings 2,400 lbs. of fodder or more per acre. To this class belong all those which can be watered at proper times and seasons, either by irrigation or inundation with good water, and the soil of which contains a considerable proportion of mild humus.

Second class. Meadows which annually yield from 1,700 to 2,300 lbs. of good fodder. To this belong meadows of the same kind as those in class the first, but the soil of which contains less humus; we may, however, frequently rank under this head elevated meadows, which receive the fertilizing moisture which drains from arable lands, and yield a product varying from 1,700 to 2,400 lbs.

Third class. Meadows which produce from 1,200 to 1,600 lbs. of fodder, composed of fine sweet-flavoured grass. To this class in general belong meadows situated in valleys and on low grounds which have a proper degree of humidity, but which do not enjoy the advantages arising from fertilizing inundations or irrigation.

Fourth class. Meadows which produce an equal or even a larger quantity of fodder, but which is coarse and rank, and intermixed with weeds and unwholesome grasses. To this class belong all those which suffer from excess of humidity, and have no drainage, and, consequently, in which there is an accumulation of standing water always existing in the subsoil, which, finding no vent, spreads itself and stagnates on the surface. Meadows situated near forests, by which they are much overshadowed, appertain to this class. These frequently yield a great deal of fodder, but it is not nutritious, nor has it an agreeable flavour.

Fifth class. Meadows which yield from 800 to 1,100 lbs. of fodder. To this class belong those which have not sufficient moisture, and are naturally prone to suffer from drought.

Sixth class. Meadows which produce less than 800 lbs. of fodder, and in which the herbage, though luxuriant, is of an acid nature, and chiefly composed of plants of the sprot, junci, or carices kind. To this class belong dry as well as marshy acid meadows.

In making this classification, I have supposed the meadows to be always carefully attended to; that is to say, the mole-hills levelled, the ditches cleared out, and the land properly watered; but I have not supposed them to be manured, for even the worst meadow land may be so improved and benefited by manuring as speedily to yield a crop almost equal to that of meadows of the first and second class.

It has often been asked, what is the proportion between the value of meadow and arable land? Many agriculturists have exaggerated the value of the former in proportion to that of the latter, because, as they justly observe, if it were not for meadows the fertility of arable land could not be maintained. Others, on the contrary, have depreciated meadow land considerably below its actual value, on the plea that by a judicious cultivation of fodder plants, much more food for live stock can be raised on arable than on meadow land.

The value of meadows as well as that of arable land results from and is determined by the amount yielded by their produce, after the deduction of all expenses. But the value of fodder is much more difficult to determine than that of grain, because in general it is less saleable.

In places where there are large markets for fodder and a great demand, we must distinguish between the price at which it would sell and the value of it when consumed at home. The former depends upon locality, and is highest in the neighbourhood of large towns, or in places whence its water carriage is easy and cheap. No general average whatever can be given. The value of that consumed on the farm also varies. It is usually increased when there is a scarcity of provision for the winter feeding of the stock and the production of manure. In places where the crops yield a great deal of straw, and where the soil is favourable to the growth of clover, lucerne, and other kinds of herbage which constitute good fodder for cattle, the grass and hay of natural meadows may be more easily dispensed with; and in places where we are sure of obtaining from an acre of arable land much more fodder than would have been produced by an equal extent of meadow land, besides defraying the expenses of cultivation, the latter will not be more valuable than the former; indeed, in the opinion of many persons, it will be of less value. But where the arable land is not adapted for the cultivation of fodder plants, the value of hay, and with it that of meadow land, is increased. The more need there is of manure for the fields, the more highly will meadow land in general be valued, especially where the soil is of a dry sandy nature, because the produce of the arable land then depends entirely upon the meadows. On the other hand, we now and then, though not often, find countries in which meadow land is so plentiful, and where there is such an excess of hay of which there is no means of disposing, that meadows are estimated at a much less value than arable land.

As we have before observed, the value of fodder is always variable, and depends a great deal on locality. Nevertheless, on an average, in those places where there is neither a scarcity, a great demand, nor a superabundance of it, 100 lbs. of hay may be regarded as equal to one-third of a bushel of rye, Berlin measure, provided that it be good in quality and nutritious; but if, on the contrary, it be of a bad quality, it will only be worth a quarter of a bushel of rye; therefore, if, as is generally the case, a bushel be valued at one rix-dollar, the value of 100 lbs. of good hay will be about eight groschen, and that of 100 lbs. of bad hay about six groschen. At this price it may usually be profitably used in the rearing of cattle, provided that the breed most favourable to the locality is chosen. I need not observe that this value, when reduced to money, will rise and fall with the price of grain.

When the value of hay is once known, that of meadow land may easily be ascertained by reckoning the amount of hay which it has produced, and deducting the current expenses. In order to calculate the expenses, we must not consider merely the quantity of hay, but must compare this quantity with the extent of ground which has produced it. For a good meadow will scarcely cost more for mowing than a poorer one of the same extent, for the haymakers' wages will be much the same in each case. The cost of carrying the hay, loading, unloading, and forming the hay cocks, depends more on the quantity of the produce than on the extent of the land. Besides, these expenses are considerably varied by the distance at which the meadows lay from the farm buildings. The expenses attending the getting in of hay from meadows at a considerable distance from the farm buildings are often double those of meadows situated nearer home; therefore no general average can be made on this point. We may, however, consider that the cost of mowing an acre of meadow land twice will be as follows:

	Rix-dol.	Gros.
Meadow land of the first class	1	12 per acre.
„ second	1	10
„ third	1	8
„ fourth................	1	8
And the cost of a single cutting or mowing of meadow land of the		
„ fifth class	0	18
„ sixth	0	16

According to the above data, if we deduct the expenses of the crop from the value of the fodder, we shall find that one acre of meadow land

		Rix.	Gros.		Rix.	Gr.
Of the first class, 100 lbs. being valued at $0\frac{1}{3}$ rix-dollar, the whole will make		8	0	net produce	6	12
„ second 100 lbs................	$0\frac{1}{3}$ ..	6	16	....	5	16
„ third 100 lbs................	$0\frac{1}{3}$ ..	4	16	....	3	8
„ fourth 100 lbs................	$0\frac{1}{4}$ ..	2	4	....	0	20
„ fifth 100 lbs................	$0\frac{1}{3}$ ..	2	8	....	1	14
„ sixth 100 lbs................	$0\frac{1}{3}$ ..	2	0	....	1	12

If we endeavour to determine the value of arable land by estimates founded on the triennial rotation with a fallow, we shall find that the value of meadow land of the same class will prove much higher in proportion. But we must remember that in this estimate all the divers expenses of cultivation are placed to arable land, while, with the meadow land, nothing but that attending the getting in of the crop is reckoned, and that the arable land yields straw and pasturage as well as other crops. From this I should be inclined to think that the relative value of a field and a meadow of the same class, would be as two to three, if, as I have before said, the circumstances of the locality are such as not to affect this proportion. It is on this account that I have been induced to divide meadows into six classes rather than into any other number, although perfectly aware that, from the infinite variations of the average produce, I ought to have established a larger number of gradations.

I have already stated that although inundations are so beneficial to meadows, and when occurring at proper seasons so calculated to increase their value and raise them to a higher class, yet they render their produce uncertain; it is, therefore, seldom that the crop of hay from meadows exposed to spontaneous inundations can be depended upon, because these may and frequently do occur at most unseasonable times. Nevertheless, this casualty has its degrees; and there are cases where the occurrence of inundations are only to be feared when there is a superabundance, or extra supply, of water; while there are others in which it occurs but once in two years. This consideration makes a great difference in the value of meadow land. There are many meadows which used regularly to yield a luxuriant crop, but which now, from the formation of sand banks or the raising of the bed of the river, yield but an uncertain amount of produce.

It is even more essential in meadow than in arable land that the surface of the ground should be perfectly level, especially when the meadows are to be irrigated, either by natural or artificial means, for without this uniformity there will be danger of the water remaining and stagnating in the hollows, while it never reaches the higher spots. Meadows, the surface of which is not even, bear a very unequal crop: in dry seasons the lowest parts yield most, and in wet seasons the highest parts; consequently, it is not easy to calculate by any general average the amount of produce which may be expected from them. Besides, where the surface is very uneven, the hay cannot be mown without difficulty.

I have already stated that the distance of the meadows from the farm buildings will cause a difference in the expense of getting in the crop; besides meadow land is always more valuable the nearer it lies to the agricultural establishment, on account of its then being more under the eye of the master, and consequently receiving greater attention. When it is thus situated, everything that happens to it—every evil can be at once detected, repaired, and obviated; whereas, if the meadow were further off, the mischief might become serious before it could be discovered. It is of peculiar importance that the meadows should be near to the farm buildings in those places where urine or liquid manures are used.

A clever man who is called upon to estimate meadow lands will take into consideration the possibility of procuring irrigation for them by means of new arrangements; or, if they are already irrigated, he will calculate the means of improving the existing arrangement, as well as of otherwise ameliorating the soil, and will carefully compare in his own mind the expenses of these improvements, with the benefits which may be expected to accrue from them.

It is a very essential point that no molehills should be suffered to exist on meadow land. These excrescences are chiefly found on dry meadows, and on the highest parts of the land, as it is there that the moles retire when driven from the lower places by moisture. Irrigated meadows, which can always be maintained in a proper state of humidity, are in general most exempt from molehills. Wherever the removal of these evils is not carefully attended to, not only will the operation of mowing be rendered difficult, and a circle be left standing round them, which cannot be cut; but these molehills will furnish a retreat for mice, ants, and other insects or vermin, and increase in size to such an extent that eventually the meadow resembles a church-yard instead of pasture land. These excrescences should therefore be cut down twice a year: in the spring, when the grass is just beginning to grow; and immediately after the first crop has been gathered in. Where this is carefully attended to, these hills will not injure meadows of some age closely covered with grass, but rather benefit them, because by this means fresh earth will be brought to the surface and extended over the ground, which is exceedingly beneficial to the grass.

Instruments of manual labour are in general made use of for the purpose of levelling these excrescences, as a spade, shovel, or fork; and care is taken that the soil shall be uniformly distributed: sometimes horse implements are employed, among which that harrow, a description of which will be found in my *Beschreibung der neuesten ackergaraethe*, heft ii., taf. 7, appears to me to be best adapted for this purpose. The harrow to which I refer is furnished with sharp irons in the front, while its hinder part is garnished with a quantity of interlaced thorn bushes. It fulfils all the purposes for which it is employed very effectually, without materially injuring the turf, breaking down every molehill and spreading the earth over the surface around; besides, the expense attending its use is much less than that of performing this operation with instruments of manual labour.

It is very difficult to level and get rid of old grass-grown molehills. If we content ourselves with removing them, a bare space is left which does not become covered with grass for some years. The best plan therefore is to cut through the layer of grass or sward by which they are covered with a spade in a cross direction, hollow out the internal part or mould, distribute it around, and then lay the turf down flat on the places where the hills stood. On meadows of considerable extent, a horse instrument termed a meadow plane or leveller, or, as some call it, a Hungarian plough, is made use of for this purpose. It is a kind of sledge, having four cross pieces, the first and third of which are armed with sharp irons in the form of a rake, and the second and fourth with teeth resembling those of a harrow. This instrument penetrates into the earth, tears and breaks almost all the turf of the meadow, and levels it beautifully; but it requires a team of at least six horses to put it in action. After it has been made use of, the meadow is harrowed in round harrowing, and then rolled. Notwithstanding the cost of this instrument, this has been proved to be the least expensive way of re-establishing the fertility of meadows that are much infested with these small elevations. The breaking up of the layer of turf admits of clover and other plants adapted to the nature of the soil being sown. This operation may be considered as a kind of semi-cultivation, and may be effected without altogether destroying the old sward.

There is a great diversity of opinion with regard to the expediency of submitting meadow land to the action of the plough for a certain period. Some persons advocate this course of proceeding, and consider it as in every way beneficial to the meadow; while others, on the contrary, condemn it as injurious and prejudicial.

It is necessary, in the first place, to distinguish between those cases in which the meadow is broken up for the purpose of being ameliorated, and those in which this operation is performed with the view of deriving a larger profit from the soil than it would have yielded as meadow land by sowing it with a rotation of other products.

In the latter case, a regular rotation is often established on it, which comprehends pasturage as well as the cultivation of corn and products of various kinds; for the land, after having borne these crops, is laid down to grass for a certain number of years, and sown with clover and other grass seeds. But this can only be done where the soil is equally well adapted for meadow land and for the production of corn. Wherever it is intended to re-establish the ground as meadow land, the following rules must be carefully observed:

1. We must take care to avoid exhausting the soil by

making it produce too many crops of corn, but must, on the contrary, carefully husband its natural fertility.

2. We must not fail to manure plentifully for the last crop which it is to produce previous to its again being laid down for meadow land; and this is the more necessary where the soil has been manured with lime to prepare it for the crops of grain.

3. While the soil is tilled, every care must be taken to eradicate and destroy all those weeds which multiply by means of their roots, otherwise they will attain such vigour as to extend themselves over the whole of the meadow.

Large crops which may thus be derived from meadow land, especially where the soil is mild, rich, and neither too wet nor too dry, by the cultivation of hemp, tobacco, large cabbages, &c.: these crops, I say, are extremely profitable, and will be, even if the meadow should afterwards yield less herbage. This, however, will never be the case, if, after observing the three rules I have just laid down, a proper quantity of clover and other grass seeds are sown; but where these precautions have been neglected, it will too frequently occur.

But if, on the other hand, it is proposed to break up the meadow in order that it may produce new and better grass, such a proceeding can only prove beneficial when the herbage is choked with weeds which are thus to be destroyed: under no other circumstances can I recommend it. Many agriculturists break up their meadows for the purpose of destroying moss, but their object would have been much better attained had they spread manure or new earth over the soil. If only one single crop of grain—as, for example, oats—is taken after the texture of the soil is thus broken up, the soil will be impoverished unless manure is added to it, the meadow will be in a worse state than it was before, and the moss will soon re-appear. Wherever it is possible to procure a sufficiency of manure, a far better effect will result from its application than would have been produced by breaking up the sward. But a single ploughing is seldom sufficient to destroy the weeds which infest meadow land; on the contrary, the loosening of the soil seems rather to favour their vegetation.

In order to destroy and completely eradicate them, we must make up our minds to bestow a thorough dead fallow on the ground, or else to have recourse to an operation which is more prompt and efficacious in its effects, viz., paring and burning the layer of turf. I must, therefore, refer my readers to what I have already said respecting the manner in which newly cleared land ought to be treated.

I have already sufficiently described the manner in which meadows should be sown on which the layer of turf has been destroyed by the plough; but my readers have totally misunderstood me if they imagine that it was my intention to advocate the re-production of grass on them being left to the operation of nature. I have met with cases certainly in which the meadows have thus succeeded better than when most carefully sown, but we cannot always anticipate such good results, as accident may lodge the worst as well as the best seeds in the ground. It has not as yet been positively determined which are the best kinds of seed, and those most calculated to flourish in certain soils.

For rich meadow land impregnated with humus, loose and moderately moist, nothing can be more likely to answer and produce a good crop of herbage than a mixture of meadow fox-tail grass (*alopecurus pratensis*), and rough and smooth-stalked meadow grass (*poa trivialis et pratensis*), either with or without clover. These seeds produce a luxuriant and vigorous layer of grass, their vegetation is continuous, and they soon shoot up afresh after having been mown; besides which their flavour is very agreeable to cattle. But they require a soil possessing all the aforesaid qualities, and, if sown on land which is deficient in them, produce only scanty and patchy herbage.

I cannot take upon myself to determine what kinds of seed should be chosen for the purpose of sowing meadows of an inferior quality, especially if these meadows are intended to last for any period of time. When we come to treat of the cultivation of fodder plants, we shall have to speak of some kinds of grasses which are peculiarly adapted for raised pasture land, or fields situated on hills or mountains, and which will not bear being transformed into meadows.

Some persons think that a newly formed meadow should not be mown at first, but that its herbage should be eaten off by cattle. Others are of a contrary opinion. While others, again, believe that the best way of rendering a meadow luxuriant is to suffer the grass to shoot up, flower, ripen, and shed its seeds; and, subsequently, to crush its dried stalks by passing a roller over the ground.

All these modes of proceeding may be advantageous under certain circumstances. By cattle being pastured on the land, especially when that circumspection is exercised which we shall presently have to recommend, the roots of the plants become strengthened, and the plants themselves extend over the soil, forming a close, dense layer or sward. The excrements voided by the cattle improve the soil, if proper attention is paid to see that they are spread about; the folding of cattle on meadow land, and the treading of their feet, likewise contributes to favour the vegetation of grass on dry ground. Whenever a newly formed meadow is well covered with grass, but the plants appear to be weak, I should recommend its being used as pasture ground.

If, on the contrary, the grass appears to be thick, and to shoot up vigorously, and we can depend upon the fertility of the soil, it will be as well to mow it, especially if this can be done early in the season, before the plants have become exhausted by their seed stems growing.

We can only advise that the grass should be suffered to grow untouched in those places where that which has been sown is exceedingly fine, and distributed in tufts or patches, separated from each other by barren places; and it is therefore judged expedient to sow the land afresh; but this can only be done where no weeds have sprung up: should such exist it must be mown. Some advise that a few spots only which are peculiarly free from weeds should be suffered to run to seed, and that they should be separated by certain intervals of space, in order that the seed may extend itself over these intervening portions.

No weed propagated by its roots should be suffered to grow in such meadows, but always pulled up as soon as it is observed. As to weeds propagated by their seeds, they should on no account be suffered to reach maturity.

That kind of cultivation which is bestowed on meadow land by means of a harrow having its teeth curved forwards, or, what is still better, that breaking of the texture and sward of grass land which is effected with instruments furnished with knives after the form of scarifiers, are the most beneficial modes of treating meadow land. They are peculiarly to be recommended for the purpose of destroying moss, notwithstanding that they act in a very indirect manner in this operation. Moss grows in places where no other plant would be able to find nourishment; it gives place to other plants as soon as they appear, perishes, becomes converted into mould, and in that form contributes to the nourishment of its successors. Aquatic mosses disappear as soon as a soil is drained, and dry mosses as soon as the land is watered. This production of nature does not, therefore, appear to be so injurious to meadow land as to render it necessary that certain definite means should be taken to eradicate it, especially as it yields to every species of cultivation that tends to strengthen the layer of turf. But the operation of which we spoke before benefits the grass and invigorates it by giving the atmospheric air free access to its roots, and thus dividing and multiplying the plants and surrounding their stems with a layer of loose earth. It is, therefore, equally as beneficial on meadows where there is no appearance of moss, especially if the soil is tenacious, as it is on those which are covered with moss. This operation should be performed in the spring, when vegetation is commencing and when the soil is dry. It appears to be peculiarly beneficial when the soil is to be manured, the manure producing a much more sensible effect when the turf has been thus opened previous to its application. The beauty and uniformity of grass land is very much increased by the use of the roll, but it must be confessed that the produce is thus decreased.

In some places even more care is bestowed on the cultivation of meadows than is devoted to arable land, and it is to the former that the chief part of the manure is devoted. When we manure our meadows plentifully, they say, we are quite sure of having a sufficiency of manure for our arable land. In other countries, on the contrary, the farmers never think of manuring their meadow land, and deem it absolute folly to deprive the arable land of any portion of the manure for such a purpose; because meadows always yield some little produce even when left totally to themselves, whereas arable land under such circumstances becomes absolutely sterile. Meadows which are irrigated and ameliorated by the overflowing of rivers, the water of which is charged with fertilizing particles and matter, certainly do not require manure. Other meadows which do not enjoy this natural advantage should receive some kind of amelioration to compensate for the nutriment annually taken from them when they are mown twice a year especially; if this is not attended to, their fertility must annually decrease. It should always be borne in mind that the produce of a fertile meadow may be converted into twice as much, or even more than twice as much, manure as the quantum which was applied to it; while arable land bearing corn crops reproduces considerably less manure than that which it required and consumed. There cannot be a doubt that the best way of increasing our stock of disposable manure is to apply it to the meadows, as by so doing we not only augment the fertility of these latter, but also obtain the means of manuring our fields and other places which we were previously obliged to leave barren for want of the means of fertilizing them. As this fact is now generally acknowledged by all clever, scientific agriculturists, how comes it that in most countries the meadows are seldom manured? Because the quantity requisite for the first amelioration is generally raised with such difficulty; for although the manure bestowed on meadow land is sure to be eventually multiplied, yet this does not take place during the first or second years, or, indeed, until after the lapse of six or seven years, the effect of the manure lasting through this and even a longer period. It is a capital which, in the time we have mentioned, is tripled and often quadrupled; but many persons are unable to advance it without impoverishing their arable land.

The same manures which are bestowed on arable land may be applied to meadows; there are, however, some which are peculiar to the latter.

Sometimes, but not often, fresh stable manure is laid on meadows; wherever this is the case it must be carried to the land and spread over it before the commencement of winter or early in the spring, in order that its soluble parts being dissolved by rain may sink into the soil. This kind of manure is, therefore, only applicable to dry meadows, where it may be carried during those two seasons. When the weather keeps dry, the undecomposed straw may be separated from the rest, gathered together with a rake, and used again as litter.

But decomposed dung, such as has been picked up in the farm-yard or on the roads, is much oftener used on meadow land, especially mixed up with earth. This manure, on account of the seeds of weeds which it contains, would be prejudicial to arable land. The sweepings of houses, sawdust, hair, woollen rags, and the refuse of the farm-yard and out-houses, may all be added to it; likewise the sweepings of granaries, barns, and hay-lofts are set aside as manure for meadows, because they engender too many weeds to admit of their being employed for this purpose on arable land.

Besides these matters, urine, or liquid manures which flow from the stable, or in rainy weather drain away from the dung-heaps, are set aside for meadow land. The liquid manure procured from pig-sties, and which is collected in reservoirs formed for the purpose, is likewise used. This is an exceedingly efficacious kind of manure, and should be applied to those meadows which lay nearest to the farm buildings. Sometimes a neighbouring brook, or a canal formed on purpose, furnishes the means of the last-mentioned species of manure, which is suffered to mix with the water, and thus diffused over the land. Another species of manure which is peculiarly adapted for meadow land, is that obtained by folding or penning sheep upon it. This, however, can only be done on dry meadows, or such as have been thoroughly drained during the spring and autumn. Four hundred sheep penned on an acre of land for two nights will manure it completely.

Mechanical manures, or those by the means of which the nutritive substances contained in the soil are dissolved, as lime, gypsum, marl, turf, ashes, soap-lees, &c., are exceedingly beneficial, especially on very moist or very dry land. They are not, however, productive of so much benefit on poor humid soils as on others. They eradicate moss, and expedite its decomposition; and it is this which renders them so efficacious on meadow land which is covered with moss, when applied after the soil has been drained.

Sometimes these alone are made use of; but the best way is to cause ameliorations of this nature to alternate with others of manure, or else to mingle the two together, and thus form a kind of compost. Gypsum, and the residue of salt works, form very beneficial manures for meadow land, and especially for such as is sown with clover, vetches, or trefoil, as both these substances tend to increase the rapidity and luxuriance of the growth of these plants. We must proceed with very great circumspection when ameliorating meadows with pure lime. This substance should be powdered very fine, and spread lightly over the soil, unless the meadow is covered with moss or weeds, in which case it may be used more abundantly and in its caustic state, in order that it may destroy these injurious occupiers of the soil.

An astonishing effect is often produced from earth being carried to the meadow and spread over it. This effect is peculiarly sensible when the amelioration of earth is of such a nature as to be appropriate to the soil.

Marshy and spongy meadows covered with moss, will be improved by addition of pure sand. It has been remarked that sand washed up by water upon meadows of this kind, has often been productive of considerable benefit when spread equally over the surface of the ground; and thus what was merely the result of accident, has proved an example worthy of imitation. The more spongy and wet the meadow is, the greater quantity of sand will it bear; and even where this sand appears to have choked and smothered the turf and grass, the herbage will, in general, be found to shoot up afresh in the following year, and vegetate more luxuriantly than ever. This amelioration of sand has a tendency to depress rather than raise the soil of meadow land, because it compresses the spongy earth, sinks into it by its own gravity, and fills up all the interstices. Sand destroys moss and facilitates its decomposition.

But when meadow land is solid and consistent, some kind of fertile vegetable earth will be found more beneficial than sand. Indeed, when it can be procured, such earth will always improve meadows, because it gives to the herbage a disposition to put forth new roots and shoots, especially in the weaker tufts of grass, and thus strengthens and multiplies the plants.

H. F. Pohl, in the "Annals of Agriculture," vol. vi. p. 274 ("Annalen des Ackerbaues"), has termed this mode of spreading fresh earth over the surface of meadows, "a renewing or making young again of meadow land." He has treated on this subject at considerable length in a work entitled "Das Verjungen der Wiesen," Leipsig, 1810, which work contains a number of judicious observations on the cultivation of meadow land in general. Dry meadow land is peculiarly benefited by an amelioration of earth taken from low grounds, even when this earth is naturally inclined to be acid. Thus, the marshy earth which is taken from the sub-strata of a soil in which ditches and drains are dug, may be beneficially employed in ameliorating the higher and dry ground, or even the upper parts of the very same meadow from which it was taken. The best plan is, however, to mix it with other earth, and then spread it over the meadow. Next to this kind of amelioration, the different kinds of marl will be found to produce the most striking benefits.

The period at which it will be most advantageous to carry manure to meadow land, must not be determined without due consideration and careful attention to all local and other circumstances. Only those meadows which are neither naturally or artificially inundated, should be manured before the commencement of winter, or the water will wash away a considerable portion of the fertilizing particles and juices contained in the manure. If, however, there are any portions of the meadow which, from lying higher than the rest, are not reached by the water, a considerable quantity of manure should be bestowed upon them before the winter comes on, either to compensate for what they lose by not coming within the action of the water, or in order that the manure may be spread over the rest of the ground as soon as the water has drained away.

An amelioration of strawy manure, when applied to dry meadows before the commencement of winter, is often productive of very beneficial effects, because the particles of dung then sink more completely into the earth; and this covering protects the plants from the pernicious effects of sharp frosts. But many persons believe that this practice is not unattended by its disadvantages, the long strawy manure affording a retreat to mice and insects, and attracting them; and such a warm covering rendering the grass plants too delicate in the spring, forcing their vegetation too forward, and thus exposing them to the danger of being cut off and destroyed by the late spring frosts which often occur after the manure has been removed. On these grounds, many farmers prefer to postpone the manuring of their meadow land with strawy dung until the beginning of spring, and then leave it on the ground until the grass shoots up.

But there is no doubt that decomposed dung and compost should be applied to meadows situated on rising grounds at the latter end of autumn, although it acts very beneficially when not spread over the soil until spring.

It is very difficult to manure wet moist meadows, especially if they are liable to inundation, at the time which we consider most advantageous; and still more so in the spring, because at that season the land is too damp and soft to admit of the manure being carried. The best plan, therefore, is to select the period immediately following the getting in of the first crop of hay. The manure will then have time to become combined with the soil before the commencement of the heavy rains and inundations of winter, which would otherwise wash it away. In fact, general experience seems to testify that manure is always most advantageous when carried to the ground and spread over it at this season.

Although we have already spoken at some length of the establishments and arrangements appertaining to irrigation, we have still some further observations to make as regards the application of this operation to meadows in particular. We have already pointed out the difference between watering by inundation, irrigation, or by causing the water to ebb back over the surface of the soil. There are some few meadows which may be watered by all or any of these three operations, yet such are rarely met with; and besides, each of these modes of watering has its own peculiar rules.

Land should be watered by inundation in the autumn and at the beginning of spring. When the cattle have been taken from the meadows in the autumn, all the trenches, furrows, canals, and sluices should be carefully examined, and if necessary repaired. Those which require the most special care and attention are the drainage furrows and canals, because the success of the operation depends upon the facility and promptitude with which the land can be laid dry after having been inundated; and besides, autumn is the best season for clearing and repairing ditches, &c. The water must be let on to the soil plentifully, and suffered to rise as high as it will, and allowed to remain there sufficiently long to thoroughly impregnate the ground. When there is a great deal of water, it frequently levels an uneven soil, the waves or ebbs of its current, especially when the wind is high, washing down all the elevations they meet with. When the water has been suffered to inundate the soil early in the season, and very warm weather supervenes, we must carefully notice whether or not there is any sign of putrefaction, the existence of which will be indicated by a kind of foam or scum which shows itself on the surface of the water. As soon as this can be detected, the water must be drained off as quickly as possible and the meadow thoroughly dried. The inundation must not be repeated until the meadow is completely dry, which will not be in less than two or three weeks.

Opinions are divided as to whether, in case of frost coming on, the water should be suffered to remain on the land, and there form ice; or, whether it should be immediately drained off. The first course has both its advantages and disadvantages. A slight layer of ice formed near the soil will do no harm. But when the surface of the water is frozen, and from the remainder being thus held stagnant the land is rendered wet and muddy, a degree of putrefaction will, in most cases, be produced even during the winter, which will injure, if not destroy, all the best meadow grasses. Therefore in meadows where the water rises much, it is always better to let it off before the commencement of winter.

In the spring, as soon as the cessation of cold weather admits of the sluices rising and falling, meadow land should be plentifully inundated, in order that the water may deposit upon it all those fertilizing particles which it has acquired during its stagnation. The inundation should be suffered to continue during a period of from eight to twelve or fourteen days, according to the temperature of the weather; we must, however, at this period, even more than in autumn, attentively watch for the slightest sign of putrefaction, and if we can detect it, let off the water directly. When the meadow has become completely drained, another inundation of about three days' duration may be bestowed upon it; and subsequently a third, lasting but one day. As soon as the grass begins to spring up, these inundations must be discontinued. After the first crop of hay has been got in, however, especially when the weather is dry, another inundation may be bestowed upon the meadow, which must not, however, be prolonged beyond a period of two days. But the period at which these operations should be performed, as well as their duration, must invariably be determined by attention to the nature of the soil which is to be operated on, and the state of the weather and temperature. The more permeable a soil is, the more frequently may it be inundated, and the longer may the water be allowed to remain on the ground. But where the land is of an argillaceous and impermeable nature, it must not be watered so often, nor must the inundations be prolonged so much as otherwise. When the weather is dry, the land may be watered much more frequently than it should be in damp weather; and the water may be allowed to remain on the ground much longer in cold than in warm weather.

On those meadows which are watered by spontaneous inundation, care must be taken to keep the irrigating canals, furrows, and trenches, as well as those intended to carry off the water, in perfect repair and good order, so that the water may not remain on the ground one moment longer than is beneficial.

Neither in inundation or irrigation should the water be allowed to flow over the land during the hottest part of the day, as it would then be likely to do a great deal of harm. Towards evening, or early in the morning, are the periods when its action will prove most beneficial.

After a white frost, or one of those cold nights which, in the spring, almost invariably succeed very warm days, watering the soil will be particularly advantageous, as it repairs the mischief done to the herbage by the cold.

In conducting irrigation, the following points must be attended to:

If the meadow has been pastured during the autumn, and the cattle have subsequently been taken up and turned into the stalls or into the straw yard, the first thing to be done is immediately to set to work and repair those trenches and furrows which have been injured by the feet of the cattle, in order that the water may flow equally over all parts of the meadow. By means of turfs placed in the furrows, and also by raising the banks of these latter with strips of turf, the water may be retained in some places, and forced to extend itself in others. When all the repairs are made, water should be let on to the meadow, in order to see if it takes its proper course, for the pressure of the feet of cattle always deranges the irrigating arrangements more or less.

An abundant and continuous irrigation may then be bestowed on the land, in order that the soil may become saturated with water, rendered more compact, and made to settle down. After a lapse of from eight to fifteen days, the meadow must be allowed to drain, in order that it may not be rendered too soft, and afterwards watered afresh. Although it is scarcely possible to irrigate land too much in the autumn, it is always best to suffer portions of it to drain and be watered alternately, even when there is a sufficiency of water to admit of the whole meadow being continuously irrigated, a circumstance, however, of very rare occurrence, especially when the meadow is of considerable extent. Wherever there is not this plenty of water, it must of necessity be withdrawn from one part before it can be applied to another.

Should a sharp frost come on during the period of irrigation, and the meadow become covered with ice, no harm will arise; besides, water which can flow on without interruption seldom freezes.

Immediately after the melting of the ice or snow, the sluices should be opened in order that the water may drain off quickly, as otherwise it will be very likely to do mischief. The first spring irrigation may last fifteen days or more; the meadow should then be left dry for at least eight days, after which time the irrigation may be recommenced, but the water must not again be allowed to remain so long on the land.

When the herbage begins to appear, which, where there are warm springs of water, and where the temperature is mild, usually occurs early in the season, the meadow land should again be laid thoroughly dry, and all the trenches looked to and repaired. Ewes should then be pastured on the meadow, as the herbage yielded by it at this season is peculiarly beneficial to them, increasing their milk far more than any other kind of nutriment would. In many counties of England the success of sheep breeding is believed to rest essentially on the pasturage yielded by irrigated meadow land, and numerous experiments have proved that such pasturage is exceedingly beneficial to sheep; it is only those grass lands on which there is stagnant or standing water which are injurious and unwholesome. The irrigations may then be continued, but the water should not be suffered to remain on the ground more than three or four days at a time. As the weather becomes warmer, however, their frequency must be diminished; and at length they must only be performed in the night. This will depend, in a great measure, on the nature of the soil; wherever the land is sandy and permeable, and the temperature inclined to be dry, the irrigation may be repeated every fourth night, and this continued until the grass is ready to be mown. The herbage growing on an irrigated meadow should always be kept fresh and green by means of water; if it is once suffered to flag and droop, the plants, from being accustomed to moisture, will suffer much more than others would, their vegetation will cease, and there will be great difficulty in bringing them round again.

Great care, skill, and attention are required in the management of irrigation; it must never be repeated until the soil has become perfectly drained, neither must it be deferred until the plants have begun to suffer from drought. In large farms it will always be best to have a man expressly for the purpose of looking after it, keeping in order, making the necessary repairs in the trenches, furrows, &c., and regulating the periods and continuance of each irrigation.

Immediately after the first crop of hay has been got in, the irrigation should be recommenced; the first may be made to last eight days, but after that it must only be repeated in the night, and when the meadow appears to require it.

Many persons particularly recommend that meadow land should be carefully weeded, and freed from all useless and injurious plants. But where proper attention is paid to the cultivation of the soil, weeds are of no great consequence, and will never attain any great height; indeed, where meadows are mown twice a year, all the weeds that do exist in them will disappear after the second mowing. It is not so, however, with meadows which are only mown once, as there the weeds have time to attain their full growth, especially where they happen to be of such kinds as cattle will not touch either in the spring or autumn. Some weeds may be completely destroyed by pasturing cattle on the meadow during the spring, as, for example, the cock's-comb (*rinanthus crista-galli*), the seed of which would otherwise form and ripen before the period for mowing the first crop of hay arrived. Thistles disappear when the land on which they grow is mown twice in the year; and when cut down before they have begun to flower, they form very good fodder.

Aquatic plants are destroyed by draining the soil, which is in fact the only way of getting rid of them entirely. The tussilago or colt's-foot, alone, which flowers very early in the year, and covers the soil with its large leaves, requires to be pulled up by the roots when found growing on a clayey soil. After it has been pulled up several successive times it will be extirpated, even though some portion of its roots should be left in the soil.

When a meadow is mowed, particular attention must be paid to see that the grass along the edges of the ditches and under the hedges is carefully cut; wherever this point is not attended to, the places thus left become absolute nurseries for weeds and poisonous plants and vermin.

Care must also be taken that no shoots or suckers from the roots of trees shall be allowed to shoot up near the hedge, as they sometimes will do, extending their roots in all directions. If the meadow is mown twice in the year, these suckers, which otherwise shoot up and multiply so rapidly, will be weakened and destroyed; but where it is let alone a whole year, the scythe is powerless to destroy them, and the only way of extirpating them will be to cut them down close to the ground, or even lower if possible. It is not necessary to tear them up roots and all, which would be a task of difficulty; if the young shoots are carefully cut off, the roots will perish of themselves.

Pasturing cattle on meadow land has been very generally condemned as disadvantageous and injurious; and many farmers have consequently relinquished the profits arising from this important branch of the rural economy.

This prejudice has, doubtless, arisen from the abuses which have crept into the system, and the injury which has often been done to the land where others besides the owner of it have had the right of pasturing their cattle there; these persons have been guided by no laws, have paid no attention to times or seasons, neither have they taken any care to select the kind or breed of animals which could be pastured on the land with the most advantage. But where the farmer has used the meadow himself, and only turned his cattle into it in the spring and fall of the year, the practice, so far from being injurious, is exceedingly beneficial, especially if the quality of the hay is also taken into consideration; because cattle pastured on meadows during the spring consume the early plants, which, if they were let alone and suffered to grow until the proper period for mowing arrived, would have become dry and strawy, and have shed their seed. Such grasses, however, while young and tender, are peculiarly agreeable and beneficial to cattle; although when suffered to grow and flower they become dry, hard, and insipid, and impede the growth of other and better herbage.

The spring pasturage ought almost invariably to be devoted to sheep grazing, provided that the meadows are thoroughly dry; for marshy meadows, the grass of which is defiled with mud, are always injurious to animals of this kind, although perhaps less so in the spring than they are in the autumn. But wherever the meadows have been thoroughly drained, this early pasturage is very valuable, and is peculiarly adapted for the nourishment of ewes, rendering their milk very plentiful and nourishing. These animals eat down the grass in an equal and uniform manner, and thus cause it to put forth more roots; and they restore to the land, through the medium of their excrements, as much if not more nutriment than they take from it. It is also said that they destroy or keep away various kinds of insects. Their tread and the pressure of their feet is advantageous rather than injurious to the soil; but it must be borne in mind that this pasturing of sheep on meadow land must be regulated by the state of the vegetation. When the spring is warm and early, the animals should not be suffered to remain on the land *(in the western parts of Germany)* after the 20th of April, and never after the beginning of May; but when the spring is cold and the vegetation late, they may be pastured on until the 10th of May.

It is by no means advisable that any kind of cattle should be pastured on meadow land in the spring of the year, unless the soil is so dry and firm that the pressure of their feet cannot make holes in the land, and unless care is taken to divide their excrements, and spread them equally over the soil as soon as they are voided; attention to this point can alone prevent this practice from being injurious to the meadows.

On the other hand, the autumnal pasturage, or that which follows the getting in of the second crop of hay, should be devoted to horned cattle, because the autumnal herbage is very apt to produce cachexy, or general bad habit of body, and gradual wasting away and loss of flesh; besides, there is plentiful pasturage elsewhere for these animals in the autumn. The grass which in some meadows shoots up abundantly and luxuriantly at this season is very nutritious and beneficial to horned cattle, and particularly adapted for the foddering of such as are in milk. At this period, there is nothing to be feared from the foot marks which the animals make in the soil, because, even where the soil is peculiarly spongy and soft, these traces will always be effaced in the spring. The dung voided by the animals is likewise very beneficial, especially when it is carefully divided and spread over the ground, which can easily be done, and should be made the duty of the herdsman.

In England, where the practice of pasturing cattle on meadow land is carried to a very great extent, the meadows are seldom mown more than once in the year, sheep are suffered to graze upon them until late in the spring, and immediately after the hay is gathered in, cattle are turned on to the ground to eat off the after-grass. The same system will be found to prevail in most low countries, where the breeding of cattle constitutes the principal object of the agricultural economy. Wherever it exists to any considerable extent, a certain quantity of grass land is allowed to each head of cattle for pasturage, and the production of hay for winter fodder. For this purpose the meadow is divided into two parts, one of which is pastured, while the other is kept in reserve from the beginning of spring until the proper time for mowing it arrives; and after the hay has been gathered in, the cattle are removed from the other portion where they had previously been pastured, and turned on to this newly mown part to graze the after-math, while the second part is allowed to vegetate in its turn until it furnishes a crop for fodder.

All the comparative experiments that have hitherto been made tend to prove, that under this system meadow land improves much more, and is rendered more fertile than it would be if mown twice in the year. The herbage is finer and thicker, and no coarse, hard stems or weeds are seen; the excrements voided by the animals manure the soil quite sufficiently; and this mode of proceeding is greatly to be recommended under certain circumstances and in certain localities, although there may be, and doubtless are, places in which it will be most advantageous to take two crops of fodder from the soil.

Both reason and experience convince us, that meadow land is much more impoverished by being mown than it is where cattle are pastured on it. Where two crops of hay are exacted from the soil, the second must always be succeeded by a manuring; whereas, the pasturing of cattle on the meadow maintains it in a state of fertility, without any extraneous means being had recourse to.

It has been found to be so advantageous to use meadows as pasture land instead of mowing them, that in some countries, and especially in England, cattle are pastured on them during the whole year. I cannot, however, recommend this proceeding being carried to such an extent; for among the various grasses which are grown for the purpose of being made into hay, those which shoot up highest appear to me to be injured by being constantly eaten down by cattle, and if long submitted to such a system, eventually perish and disappear. A meadow which has been pastured, certainly produces very fine, thick herbage, when afterwards left to vegetate unimpeded; but the grass on it is always very short. If the soil is sufficiently rich and fertile to ensure a plentiful and luxuriant crop of this short grass, it may be advantageous to submit the meadow alternately to pasturage, and to the scythe; but, otherwise, it appears to me to be exceedingly prejudicial to meadow land to pasture cattle on it during a whole year or more without interruption.

Meadows are divided into those which yield *one*, *two*, or *three* cuttings, or crops of hay; and the first is subdivided into early and late meadows. But this distinction depends chiefly upon the manner in which they are cultivated, and not unfrequently on the more or less exclusive right which the agriculturist possesses over these portions of land. For even those meadows which are mown but once a year are capable of yielding two crops, if properly managed, and if they are the absolute property of the farmer. The claims of others, besides the person who rents it, on meadow land, usually arise from its having, at some previous time, been common land; but these claims are so prejudicial to the interests of agriculture, that wherever attempts have been made to increase and advance the national welfare, every exertion has been used to do away with these hereditary claims, and release the farmer from a tax which cramps his energies and impedes improvement.

THE HAY HARVEST.

The getting in of the hay crop is one of the most important of all the agricultural operations, and requires great activity and industry, as well as skilful management and constant attention.

The exact period at which this operation should be undertaken cannot be specified, although many persons pretend to lay down rules with regard to it. It is influenced not only by the nature of the soil, the situation of the meadow, and the kinds of grass which grow there, but also by the state of the temperature, and the advancement or backwardness of the season. The best way is to commence mowing as soon as the chief part of the herbage is just preparing to flower; for were we to commence sooner, the quantity of hay obtained would not be so great; and if the operation is postponed until later, the quality of the hay will be deteriorated. Where it is intended that the meadow should be mown two or three times in the course of the year, the first crop should always be got in as early in the spring or summer as is practicable, in order to allow more time for the vegetation of the other two crops; thus the second being ready for cutting sooner, the third is rendered more abundant: in those places where considerable value is set on the aftermath, the first crop of hay is always mown very early in the year.

As the difference in the temperature has so great an influence on vegetation, it will readily be understood that the herbage is not always ready to be mown at the same period. In a warm rainy spring, the hay harvest will be at least three weeks earlier than it will be in a cold dry season. Sometimes the vegetation of the long grasses is very forward, while that of the short grasses is altogether as backward; so much so, indeed, that it is almost impossible to commence mowing. But it not unfrequently happens that when the short grasses are backward at the time the first crop is mown, they shoot up vigorously and luxuriantly against the period of the second mowing; this is not, however, always the case, for where the weather is dry and unfavourable, these grasses are often even more behind in their vegetation at the second than they were at the first mowing. Whenever the tops of the short grasses have suffered from frost, it will always be found beneficial to mow them, as they are thus induced to put forth new shoots. Where their vegetation has been retarded by drought, and this state of weather is succeeded by much rain, they will shoot up very rapidly without anything being done to them.

Temperature has in general a very great influence on the luxuriance as well as the period of the hay harvest. However vague may be the data which we possess respecting the indications of alterations of weather and temperature, and although these data are in general founded on prejudices and old saws, yet it is well known that in general there is a considerable change of temperature about the 21st of June, or the period of the summer solstice. If the former part of the summer has been dry, a fortnight's rain, or even more, may be expected. On the other hand, if the early part of the summer has been wet, and the weather seems inclined to clear, fine and favourable weather may be expected. It is on this account that those who have had their spring meadows mown early are best off in the former case, even though at the period of the mowing the short grasses were very backward, for this herbage shoots up most luxuriantly during the wet weather which succeeds to the dry. But, wherever the mowing cannot be performed before the commencement of the rainy season, it should be deferred until there is a reasonable prospect of settled fine weather again. All these contingencies should be carefully weighed, and the nature and position of the meadow taken into consideration, before the period best adapted for cutting down the hay is fixed upon.

The operation of mowing requires great attention and care; it is of the utmost importance that the herbage should be cut down as close to the surface of the ground and as level as possible, without, however, touching the necks of the plants or injuring the sward. This, however, can only be done upon even meadows which are thoroughly free from stones and inequalities. Neither can it be effected when long scythes are used, or where the mower takes long sweeps or swaths; for, although such a mode of proceeding tends to accelerate the progress of the work very much, a more circumscribed swath is to be preferred, as it enables the labourer to cut the grass closer to the ground and more equally. It makes a very great difference in the quantity of the hay crop, whether the grass is cut close to the ground or not, firstly, because the herbage is much thicker the nearer it comes to the ground; and secondly, because experience has testified that it is much more advantageous to the young shoots that the grass should be cut down close, than that it should be left long and uneven.

As it is much easier to get the labourers to mow in this way when they work by the day than it is when they are at task work, I cannot but consider the former to be most preferable. Day work has also another advantage, viz., that the labourers may then be employed either in mowing or haymaking, according as they can be of most use.

Where the land is even, a man can easily mow an acre and a-half per day. Skilful workmen, who mow by piece or task work, generally get through more than this, and will sometimes do twice as much; but then it is not so neatly and well executed.

There are various ways of making the hay, which are followed according to the kind of hay which we wish to have produced, and the state of the weather at the period of hay-making.

There are two kinds of hay, *green* and *brown* hay.

The quality of green hay is always improved by the grass being spread about, and divided immediately after having been mown, and thus exposed to the influence of the sun and air; but it must be carefully protected from moisture, and from dew and rain, by putting it in heaps. As soon as the dew is evaporated, all the grass which has been mown in the early part of the morning should, if the weather is fine, be scattered about, and great care taken to shake it free from lumps and divide it thoroughly. As soon as this has been done, the haymakers should go back to the spot where they commenced, and turn over or move with a rake that portion which was spread out first; at noon this should be repeated; at four o'clock the hay should be raked up into semi or perfect circles, and, before sunset, made into grass-cocks. The business of the second day commences with tedding all the grass mown early in the morning, as soon as the dew is off the ground; the grass cocks should then be shaken out into what are called straddles or plats, each of about a perch and a-half or two perches in breadth; between each of these a vacant space should be left to admit of the hay being turned towards either the upper or the lower part of the meadow when it is moved at nine o'clock and at noon; towards evening it should again be brought into circular ridges, and before the sun goes down again made into grass-cocks, which latter must however be three or four times as large as those of the preceding day. The same course of proceeding must be continued throughout the third day, and by that time, if the weather has been sunny and fine, this hay will be dry enough to be gathered together in one large heap, preparatory to its being carried off the ground. But if any appearance of moisture is perceptible in the heap, it must be shaken out again, and the hay once more spread over the ground, though not thinly as before, and suffered to remain until every particle of moisture is evaporated.

All the grass which is mown after the early part of the morning should be left in the swaths or sweeps in which it fell from the scythe until the following day, and then submitted to the process we have just been describing. Every morning the newly mown grass should first be tedded and spread about, then the heaps shaken out into plats, the small ones first, and then the larger ones; and after this has been done, the labour must be divided among the whole of the operation. Until some portion of the hay has been stacked or stored up in the hay loft, the amount of work to be done will increase every day, and more hands will be required to accomplish it properly.

Hay thus prepared retains its green hue, its aromatic scent, and indeed nearly all its most useful properties; it only loses its aqueous portion, and does not experience fermentation. Where an extra number of hands can be procured, and the weather is favourable to the performance of the operation, equally as much is gained by the advantages arising from the work being expeditiously performed as is expended in the wages of the additional labourers, and, on the whole, the expenses are but little greater than they would have been, had the operation been performed in an imperfect and dilatory manner.

Some farmers suffer the grass to remain on the spot where it was dropt from the scythe for two or three days before they begin to move it. There cannot be a doubt but that much labour is thus saved, because the grass having become faded dries much more quickly, but the hay thus produced is never so green.

When the weather is rainy, damp, or changeable, the hay cannot be so rapidly prepared. The chief point to be aimed at in this case, is that of keeping the cut grass as much together as possible, in order that the water may not wash away its succulency, and yet to give it sufficient air; every moment of fine weather must be taken advantage of to move it about, otherwise there will be danger of its fermenting. So long as the grass continues green, retains its succulency, and, in a manner of speaking, its vitality, so long the humidity which falls from the atmosphere will not do it much harm; and when rainy weather sets in immediately after the commencement of the mowing, or the operation has been begun during rain, but in the anticipation of fine weather supervening, in either of these cases the grass should be left just where it was cut, until the weather is more favourable; should it, however, be too much pressed down by the moisture, it must be gently raised with a rake, and then it may be suffered to remain a long time in this state without there being any danger of its deterioration, provided, however, that there is no stagnant water on the ground. Wherever this last named evil exists, the whole, or as much as possible, of the grass must be removed to the highest parts of the meadow. Rain is most injurious to hay when it has lost its vitality and is partly dry; it then actually deprives it of its most nutritious particles. Hence it will be evident that great care should be taken to prevent the hay from being rained upon while it is spread out over the ground to dry; so soon as there is the least threatening of a shower, all the grass should be gathered together and the dryest parts made into heaps. When this precautionary measure has been taken, the hay will bear a continuance of heavy rain without suffering much deterioration, especially if the temperature is not very warm. The external part of the heap alone loses colour and flavour, the interior portion remains green and retains all its succulency; and when the weather clears, and the hay can be spread over the ground, one dry day will frequently suffice to render it fit to be stacked in case more rain is anticipated.

When the wet weather continues for a considerable period without intermission, air must occasionally be admitted into the heaps or cocks; and care must be taken that the hay does not become heated. Should this misfortune be produced by the warmth of the temperature, the best way of managing this half-dried grass is that recommended by Klapmeyer, which we shall speak of more fully when we come to treat of the getting in of clover crops; it consists in uniting it all in one large hay-cock, in order that it may be equally heated throughout, subsequently shaking it out, and spreading it over the ground; and then, when it has become dried by the air, collecting it afresh. When it has once become over heated, it will not do so again; its colour and smell changes, but it will not turn mouldy or contract any disagreeable flavour, and will always be adapted for the feeding of cattle. It will, of course, be understood, that this mode of hay-making ought never to be practised upon natural meadows, unless in cases of absolute necessity.

There is another way of making green hay, which saves a great deal of labour; this is but little practised, although highly to be recommended. I shall now describe the details of the operation.

As soon as the grass is thoroughly freed from moisture, it is put, while yet green, into narrow heaps, which are made as high as possible; and to prevent these from falling down, a small stake is driven into the ground, round which the grass is carefully arranged with the hands. A handful of grass is then taken from one of the swaths, and the longest and strongest portions are chosen from it, to cover the top of the heap or hay-cock with, care being taken to turn the upper or flowering part of the grass downwards. These pyramidal heaps are then suffered to remain until the grass of which they are composed is thoroughly dry, which is generally some where between the eighth and fifteenth day; on the heap being opened, the grass in the interior of it will be found to retain its hue and freshness. I have seen grass thus made into large heaps, during dry and windy weather, which has dried very rapidly without requiring to be moved, and has been quite green. Temporary rain or showers will not do it any harm, beyond that of depriving the external part of some portion of its colour; but should the wet weather continue for any considerable period of time, there is a possibility of the hay becoming too much compressed: it will then be necessary to open the heaps, and shake and loosen the hay, in order to prevent it from acquiring an unpleasant flavour.

There are some meadows, the greater part of the herbage of which requires to be exposed for a short period to both wind and rain, in order to get rid of its injurious properties, and render it agreeable and profitable to cattle. This is the case with all the large and hard grasses, not only the reeds and rushes but also the blue hair grass (*aira cerulea*), a plant which is so often found on damp, low ground. It has been observed, that cattle which are fed on hay containing a considerable portion of this plant, lose their strength when the hay has not been exposed to the air and warmth for a proper period. Such hay should be left upon the ground for five or six weeks, in order that it may be repeatedly wetted and dried again.

Brown hay is made by allowing the grass to remain for a day or two, or, if the weather is unfavourable, for even a longer period, where it was cut; afterwards, when it is dry, it must be shaken and turned, and subsequently formed into small heaps. When it has remained thus for some days, these heaps are united together, so as to form larger ones. These, also, are left standing for some days; after which period, the hay is collected and formed into large cocks. There it becomes heated, perspires, dries again, and eventually becomes like a block of peat. During this process, no air should be suffered to come in contact with the hay, and, instead of shaking and moving it, it should be compressed as much as possible, in order to exclude the air; for, wherever this is not attended to, putrefaction and mildew will be engendered. This kind of hay, which is seldom stored in lofts, but made into cocks and ricks, may, when required for use, be cut with a knife, sharp spade, or hatchet. In many countries the farmers are greatly prejudiced in favour of brown hay, and assert that it forms a far better fodder for cattle than green hay does; in support of which assertion, they narrate various experimental trials made with the latter, all of which have turned out unfavourably. But if we come carefully to examine into both sides of the question, we shall find that in those places where the preference is given to brown hay, the green hay is almost always carelessly or imperfectly made; in which case there can be no doubt but that the former will be preferable. There are many recorded experiments which satisfactorily prove that good green hay is decidedly the most nutritious and advantageous, whether employed as fodder for horses, sheep, or milch cows; oxen only which are put up to fatten thrive best on brown hay.

Various instruments have been invented, with a view to diminish the manual labour of hay-making on extensive meadows, and by means of these a great portion of this operation may be executed with the addition of horse-power.

Bloys de Treslong, in "The Acts of the Rotterdam Society," vol. ii. p. 88, describes a harrow which is made use of to turn the hay, and submit it more perfectly to the action of the air and the sun's rays. This instrument is composed of two pieces of wood, each nine feet long; and in each of which there are seven long teeth, made either of wood or iron. These portions are united together by three cross pieces of about four feet four inches long. A horse is harnessed to the instrument on which a man or a boy mounts, and guides it up and down the meadow, by which means the whole of the hay is moved and turned over. This invention is, however, only useful in fine dry windy weather. It may easily be supposed that the hay thus made is equally dry and no way inferior to that formed in the usual way, although considerably less manual labour has been expended on it. A second labourer must always follow the harrow in order to raise it up when the hay becomes collected between its teeth.

A horse-rake may be made use of for the purpose of gathering the hay together from the sweeps or swaths in which it was cut, a similar instrument to that which is usually employed on the stubble of corn-fields; and a hay-sweep is frequently used to accumulate the hay in heaps, to each extremity of which is attached a cord or chain, the other end of which is affixed to the harness of a pair of horses. On each side of the tree or piece of wood which forms the sweep, a man gets up who holds by a cord affixed to the reins, and bends slightly forward. The horses are then put in motion, and the hay is gathered together in front of this machine so quickly and thoroughly, that if the meadow is tolerably even, only a few stray bits are left here and there on the ground. When the labourers think that the heap is sufficiently large, they spring to the ground, still, however, holding by the cord; and the tree being no longer borne down by their weight, slides over the heap of hay. They then remount and proceed. This operation cannot be well performed, unless the persons employed are skilled in it.

Mr. Middleton, an Englishman, has given a description of a similar but much more complicated instrument, which account has been translated into German by Leonhardi, and published at Leipsig in 1797.

The carting and carrying of the hay are operations which are always executed much better and more promptly when the persons employed are accustomed to the work. As the bulk of hay is always very great in proportion to its weight, much nicety and skill are required in making the load such as a team can draw without difficulty. Therefore, a person skilled in loading hay, whether male or female, should always be selected for the performance of that work and encouraged. Neither must this operation be too much hurried, but time allowed for the hay to be divided and spread out in even layers, so as to maintain the equilibrium of the whole. Much more time is actually gained by proceeding gradually and surely, than by acting with precipitancy; for it is impossible for the person employed in loading to execute his share of the labour properly, if more hay is presented to him at once than he can possibly arrange.

In general, a relay of waggons is required, and the operation always progresses more rapidly when there is a pair of horses or oxen which can be made to draw the waggon that is being loaded, from one heap to another. The waggon ought always to be placed between two heaps in order that it may alternately receive hay from either side, unless there happens to be a high wind, in which case it must be so placed that the wind shall blow the hay towards it.

The first thing to be done is to establish a due proportion between the number of labourers employed in loading, unloading, and stacking, and the number of teams and waggons. This proportion, however, must be regulated chiefly according to locality, and, therefore, merely general rules can be given for determining it. Everything should be arranged so that one part of the operation shall not be retarded by another; that nobody shall be idle, and yet that nobody shall be too much hurried.

The back of the waggon must always be carefully fastened up and finished off, in order to prevent any hay from being lost on the road.

The hay, when properly made, is either stored in boarded lofts or granaries situated over the stable, in which the cattle are kept that are to consume it; or else it is formed into stacks, ricks, or cocks.

In storing it up, care must be taken that it is spread out in uniform layers, and piled together so compactly that no vacant spaces shall be left; for mildew is invariably engendered by such vacancies, and the moisture produced when the hay becomes heated also collects there. Where this is the case, the hay sometimes becomes so much heated as to give out vapour; and then, so far from loosening it, or lifting it up and giving it air, we must, as far as possible, endeavour to prevent the least breath of air from coming to it, and close up the shutters and all the outlets of the loft. Under these circumstances, the hay may ferment very much and turn brown; but it will not be spoiled, nor will there be so much danger of its taking fire. It is only when a free current of air is allowed to come to it that the inflammable gas, which, under such circumstances is evolved, will be likely to take fire. We must not, therefore, touch the hay, unless it is to take it quickly out of the loft to cool and dry it again.

If the hay-loft is thatched with a good straw roof, the hay must be piled as near to that roof as possible, and pressed down so compactly that no interstices shall be left between the two. When no portion of the hay is in contact with the air, it goes through its heat without receiving any damage, and every portion retains its quality and nutriment. Where the roof is of slates or tiles, the upper layer of the hay is very apt to lose its flavour, and become damp and mouldy.

It is well known that if we would have fodder preserve its good qualities, and not acquire a flavour and smell disagreeable to cattle, we must prevent all the vapours and miasma of the stable from penetrating through the floor into the stored hay situated above.

Arched floors, composed of boards covered with straw or reeds, are best adapted for preserving the store of fodder destined for the cattle beneath.

When distributing the different kinds of fodder in the granaries and lofts, great care must be taken to apportion to each variety of animals the kind of fodder which will be most agreeable to their palate, as well as beneficial for them; and to distribute the different kinds of hay through each loft in the order in which they are to be consumed, so that there may be no difficulty in getting at each one as it is wanted.

But it is far more advantageous to stack hay than to keep it in lofts or buildings of any kind. When the hay cocks or stacks are properly formed, the hay will be preserved much better and in a more wholesome state than it ever can be in confined buildings, because those vapours which exhale from it, and which are so apt to engender mildew and an unpleasant flavour, are carried off by the air as soon as they reach the surface of the stack. This is the reason that, in England, farmers and dealers in hay and straw always assert that they can distinguish housed from stacked hay by the smell; and also that the latter is so much preferred, and will always fetch a much higher price. Each kind of hay should be made into a separate stack, as the farmer will thus be enabled to select that which he thinks proper for use; and will also be better able to keep the hay from one year to another. Hay and fodder stacks are sometimes built upon a floor or groundwork, formed for the purpose of stones or boards, or, what is still more common, on a bed formed of dry branches and straw; but an elevated and dry spot should always be selected for the site of a hay-rick. On one of the foundations just mentioned, the fodder may be spread out by armfuls, and arranged in regular beds one above the other, each trodden down and compressed as much as possible. From the base up to a certain height, the stack should continue to swell out and enlarge in circumference, and then gradually diminish, until the eaves or summit assumes the form of a roof, terminating in a point. Lastly, this roof should be covered with straw for the purpose of protecting the hay, and carrying off the water and rain without its doing any injury to the stack.

Hay-stacks are made in various forms; sometimes they are round, at others square, but their most general form is that of a long square or oblong. This latter is usually preferable, because the stacks which are built in this way may be lengthened at pleasure, and all the crops of the year formed into one large stack, should such a course of proceeding appear to be advisable. One of the gable ends should be directed towards the north-west, or that point from which most wind and rain may be expected, in order that the least surface may be presented to the action of the elements. The surface of the top must be arranged at this gable end in the form of the slope of a roof.

When a stack is finished, all its roughness should not only be taken off with a rake, but the sides should also be carefully and evenly cut. If any hollows or inequalities appear—a circumstance which should, however, be as much as possible avoided—they must be carefully filled up, in order that no moisture may find a way in. Lastly, the stack should be covered up with straw, and a trench dug all round it to carry off the dripping of the water.

The long stacks have one great advantage over all others, namely, that the hay may be easily cut from them when required for trussing or for consumption, provided that it is cut off perpendicularly, and on the opposite side to that quarter whence most wind and rain come. The hay and fodder stacks should all be placed in one yard or enclosure set apart for the purpose, and surrounded with fences or walls: it is much easier to watch the progress of the consumption of the winter stores when they are thus placed, than it is when they are laid up in granaries, and consequently the farmer is enabled to regulate the expenditure of food according to the stock in hand.

Those floorings of boards or planks intended to serve as the basis of hay-stacks, and which are united with a moveable roof that can be raised or lowered at will, are now scarcely ever made use of, being not only expensive but very inconvenient; and the hay being equally as well, if not better, preserved when exposed to the air. Those tunnels or tube-like vacuums which it was formerly customary to leave in the centre of every hay-stack that was built, for the purpose of carrying off the vapour engendered in it, are now quite abandoned; for experience has proved that the portions of hay nearest to them were always the first to spoil. Indeed, fodder can never be more effectually preserved from injury than when all communication with the open air is entirely cut off, and every approach to a vacuum avoided. The inconvenience of these tunnels, and the difficulty of forming them, are also arguments against them.

The hay-stacks or ricks, which are formed in meadows at some distance from the house, and are usually placed upon a raised scaffold or frame, when these meadows are liable to become covered with water during the winter, are generally very carelessly made; nevertheless, they turn out, on the average, exceedingly well. In countries where there is a great deal of meadow land, and where the chief part of the hay is made expressly for the purpose of being sold, these temporary ricks or stacks are very much used; there will not, therefore, be any occasion for us to enter into any minute description of them. They are to be considered merely as the means of meeting an exigency, and not in the light of permanent stacks.

Those persons who have tried the effect of forming their hay stacks of alternate layers of the straw of the spring corn which was left from the preceding year, and hay, have spoken very highly of the practice. They chiefly recommend it upon this ground, viz.—that the fodder can be compressed, even when not perfectly dry, as the straw will absorb all the humidity proceeding from the hay. The straw becomes impregnated with the flavour of the hay, and is thus rendered more agreeable and palatable to cattle, and is, consequently, eaten by them more willingly. This practice has chiefly been applied to clover hay, we shall therefore recur to it again when treating of that crop. Some agriculturists have recommended that the hay should be salted while being stacked, especially if it has at all suffered from the effects of wet or bad weather, or has contracted any unpleasant flavour; and they assure us that by attention to this salting process, the hay will be rendered exceedingly palatable to cattle. I have not as yet heard of any decisive experiments having been made on this subject; there is, however, little doubt but that the practice might prove advantageous where salt is tolerably cheap.

A distinction is made between hay properly so called, or the produce of the first crop of grass, and the aftermath, or grass which constitutes the second crop; and where the meadows are particularly fertile, there is also a third class of hay, or that arising from the third crop of grass.

The manner of making and preserving the hay of the second crop differs in no essential particular from the same process when applied to the first, except as regards such modifications as are rendered necessary by the advanced state of the season, or the difference in the weather and temperature. In order, however, to prevent such hay from igniting and taking fire while in the stack, it must be allowed to remain in the swaths upon the ground for a longer period before being moved, in order that it may become perfectly dry, for the moisture is not so easily and rapidly evaporated from the second crop of grass as it is from the first, or that cut in the earlier part of the year. On this account it is desirable, previously to its being spread out and turned, to suffer it to lie in the swaths as the mowers have left it for several days, in order that its vitality may be completely destroyed.

When the second crop of hay can be got in thoroughly dry, and has been grown during fine, warm weather, it is even more nutritious than the hay of the first crop. We shall speak of the use of hay when we come to treat of the management of cattle.

ON THE VARIOUS KINDS OF PASTURES.

In a previous chapter we have already pointed out the advantages attendant on the stall-feeding of horses and cattle; undeniable however as these are, it frequently happens that we are compelled to pasture the cattle either because the circumstances of the establishment require it, or because the nature and situation of certain pasture-grounds prevent them from being otherwise rendered available. But, wherever any considerable number of sheep are kept, pastures are quite indispensable; for although it has been shewn by undoubted experiments that sheep may be fattened in enclosures on grass cut and carried to them, yet the general introduction of this practice would be attended with many inconveniences and difficulties, which we shall have occasion to allude to by and bye.

The estimate, valuation, and cultivation of pasture lands, as well as the methods of turning them to the best advantage, constitute therefore an important branch of agricultural science.

The several kinds of pasture ground are thus distinguished from one another:—

(*a*). Lands devoted alternately to pasture and tillage. Those portions of the arable land which are chiefly devoted to the produce of corn, but which, nevertheless, are from time to time laid down as grass land. To this class belong—

1. Pasturage on the unemployed portions of land subjected to the system of alternate tillage and pasturage, and that on land which bears a crop of corn once in three, six, or nine years only.

2. Pasturage on fallow ground.

3. Pasturage on stubble fields.

(*b*). Spring and autumn pasturage on meadow land.

(*c*). Extra pasture lands: those, the soil of which is at the same time mainly devoted to a different use, the pasturage of cattle not being the chief produce derived from them.

(*d*). Permanent pasture lands: or those which are constantly and exclusively devoted to the growth of herbage, and the pasturing of cattle.

These pastures are in general private property, or at any rate under the sole control of the lessee; but at times various individuals possess rights over them which totally nullify the value of the land to the farmer. We shall first consider pasture grounds as private property, and, subsequently, as under the control of various individuals.

It is customary to value pasture ground by calculating the number of cows which can be fed upon it during summer; the number of head of other kinds of cattle which such land is capable of sustaining may subsequently be determined by calculations deduced from the first estimate. Three acres of ground are usually allowed to be the extent required for the support of a cow.

A horse requires four acres and a-half; a draught ox three acres and two-thirds; a colt two acres and a quarter; a sheep three-tenths of an acre; a pig three-tenths of an acre; a goose one-tenth of an acre.

These proportions are, however, liable to variations arising from the breed or size, or peculiar properties of the different kinds of animals, and also upon the amount of nourishment which certain varieties require; in places where sheep are scantily and badly fed it is usual to reckon fourteen of these animals as equivalent to a cow when calculating pasture ground; while, on the other hand, in those situations where the farmer attaches great importance to the nurture and breeding of his sheep, he only allows eight to each cow.

But before we proceed further, it will be as well to understand exactly what is the extent of pasture ground which should be allowed for each cow. A cow belonging to one of the large breeds of cattle, such as are found in the low countries, requires four times as much pasturage, if not more, than would suffice for the keep of a cow belonging to one of the smaller breeds, such for example as those which are found in hilly countries, where the soil is poor. Neither of these extremes must, however, be taken as the basis of our calculation; we must select one which is of a moderate size, and adapted for grazing on the portions of land laid down to grass on a farm conducted under the system of alternate tillage and pasturage. A cow of this description will weigh about 450 lbs. while alive, and yield 250 lbs. of butcher's meat when dead. If allowed sufficient pasturage, she will annually yield about 80 lbs. of butter. The extent of pasture ground on such a managed farm as we have just been speaking of, which a cow of this description will require, has been calculated with the utmost accuracy; and from that calculation may be deduced the proportionate extent of other kinds of pastures which will be required for the same purpose.

In order to be able to form an estimate of the luxuriance of the pasturage which will be yielded by a field or portion of arable land laid down to grass, in a farm subjected to the system of alternate tillage and pasturage, it will be necessary to take into account the following circumstances:—

1. The fertility or richness of the soil, which is proportionate with the luxuriance of the corn crops which it yields.

2. Grasses do not, however, shoot up and flourish most where the crops of grain have been most luxuriant, for, although there may not be a shade of difference in the soil of two fields, one may, from situation, from being more wet than the other, or from various other circumstances, be less adapted for the production of herbage. The difference, however, is not actually so great as it appears to be, the fine and scanty grass being often more nutritious than the abundant and coarser herbage.

3. The fertility of pasture ground depends in a great measure upon the number of corn crops which it has been made to yield since it was manured, for every one of these tends to diminish the richness of the soil and its disposition to produce herbage.

4. A good deal likewise depends upon the time which has elapsed since that portion of land was previously left at rest. If seeds have been sown upon it, the grasses and herbage seldom spread or shoot up very much during the first year; indeed, the plants which have been sown, which are in general Dutch clover, pimpernal, and ray-grass, scarcely make their appearance above ground during the first year. On ordinary soils, the pasturage is most luxuriant in the second and third years of rest. During the fourth and fifth years it usually diminishes in

quantity; this is frequently occasioned by the growth of moss and weeds. This decrease depends, however, very much upon the condition of the land; for, on a rich soil which is in good condition and consequently favourable to the reproduction of herbage, this decrease is not perceptible; on the contrary, it is even asserted that the quantity of pasturage goes on increasing—an effect which may, in a great measure, be attributed to the quantity of dung deposited upon the soil by the greater number of cattle which it supplies with food.

At page 138, Vol. I., I have given the table in which Meyer states the extent of ground required for the keep of a cow at grass during the whole summer.

If six acres of pasturage or more are required for the keep of a cow during the summer, it is evidently by no means advisable to graze horned cattle; a soil of this description can only, therefore, be advantageously employed as pasturage for sheep.

In the rotation which includes alternate tillage and pasturage, the pasturage of those portions laid down to grass or rest constitutes a very essential item in the revenue, nor indeed can it be dispensed with, if we would maintain the harmony of the whole; therefore every means which should present itself of increasing the fertility of the pasture ground must be adopted; even at the seed time these important portions of the farm must not be neglected. In the old system of alternate tillage and pasturage, especially as it exists in Holstein, where this system is carried on in all its primitive simplicity, the agriculturists did not like to till their ground or bestow a dead fallow upon it, because these operations tended to destroy the roots of the grass plants; and, consequently, the land did not become so quickly clothed with verdure when left in repose. The value of the pastures was seldom lost sight of by them, and autumnal corn was usually the last crop sown previously to the field being laid down to grass, because herbage shoots up more abundantly among this description of crop; or, if oats were sown, the land was only ploughed once for their reception, and that very superficially. It cannot be denied that this mode of proceeding was exceedingly proper, if the chief object which the farmer had in view was to favour the growth and increase of grass, and he was unable to discover any other means of attaining his end. It was a considerable period before any other means of raising fodder was generally adopted, for it was believed that the nutritious properties of natural herbage could not be adequately replaced by any plants artificially sown. This prejudice, however, no longer exists among intelligent and enlightened agriculturists, and it is now the general opinion that the herbage of a field sown with judiciously selected grasses, equals, if not surpasses, any natural pasture which can be met with.

Dutch clover is usually selected for the purpose of sowing land destined for pasture. The preference is given to this plant on account of the smallness of its seed; its tendency to propagate its plants by shoots or offsets from the roots; the facility with which its seed may be gathered, and the consequent low price at which it can be obtained. Two pounds of Dutch clover seed are quite sufficient to sow an acre of ground, if evenly scattered over it. Purple clover is, however, frequently mixed with it, partly for the sake of obtaining a larger crop of hay, and partly because Dutch clover only thrives on soils which are in tolerable condition.

Ray-grass (*lolium perenne*) also answers very well when sown in conjunction with Dutch clover, as likewise does sheep's fescue-grass (*festuca ovina*). Both of these grasses form very thick and luxuriant pasture, and thrive well on high and hilly ground; there is little or no difficulty in gathering their seed, and, consequently, it is not expensive. From fifteen to twenty pounds must be allowed per acre, in addition to the seed of the Dutch clover. Some farmers state that they have sown woolly soft grass (*holcus lanatus*) for the formation of pasture, and with very good effect. The seed of this grass is also easily gathered; it is true, that there is some difficulty in getting it out of the pod or husk, but this trouble need not be taken where the seed is intended for home consumption, and not for sale. When sown in the husk, a bushel per acre must be allowed. This grass always grows in tufts, and is particularly conspicuous towards autumn, at which season its radical leaves shoot out vigorously. In my opinion, however, nothing but necessity induces cattle to eat it, and they leave it untouched whenever they can find any other kind of herbage. Besides, it is so easily destroyed by frost, that no dependence can be placed upon it.

The pimpernel burnet (*poterium sanguisorba*) is an excellent plant for the formation of pasture, although as yet it is but little known umong us; it will thrive upon very poor soils, where Dutch clover will not grow at all; it cannot, however, be denied, that it yields a far more luxuriant herbage when sown on rich land. It retains its verdure even in the depth of winter, and in the beginning of spring shoots forth with the utmost vigour. It is particularly adapted for sheep, and these animals always eat it with avidity; it is agreeable to their palate, from its aromatic and slightly astringent properties. The seed of this plant may easily be collected from any portion of the field set apart for the purpose; it must, however, all be carefully gathered with the hand. On hilly and chalky fields, where the layer of vegetable mould is very superficial, quaking grass (*briza media*) will be found well adapted for the production of pasturage; sanfoin may be sown, in conjunction with this, with good effect on such land.

We shall again recur to this subject before the conclusion of the work.

We may, to a certain extent at least, include in the same class the pasturage on *outer fields* or *crop divisions*, during those years in which they are laid down to rest. My readers will remember that, when treating of the cultivation of grain, the above-mentioned term was applied to fields or divisions of land remote from the farm buildings, and more or less impoverished, and which, from want of manure, yield only one crop of grain in three, six, nine, or even twelve years. It will be scarcely necessary for us to observe, that the pasturage derived from land which is continually impoverished by crops of grain, and which receives no compensation, in the shape of manure or otherwise, for the exhaustion they undergo, cannot be placed in competition with that derived from corn fields which have been properly manured, and then laid down to grass; the former are covered with small, weak, shrivelled plants, and very often with nothing but goat's beard (*aira canescens*), knawel (*scleranthus annuus*), some of the smaller fescue grasses, and sweet-scented vernal grass (*anthoxantum odoratum*); the latter of which, cattle will not touch when it is in an advanced stage of vegetation. Pastures of this nature are, therefore, rather to be regarded as places to which the animals may be turned for exercise than as actual pasture grounds for either sheep or swine; for, far from nourishing, they only impoverish these animals. The produce of such land can only be depended on when certain portions of it are low and damp, and, consequently, unfit for the production of corn; these spots become covered with coarse grass, and hunger compels the animals to browse on them; but as it frequently happens that in such situations the grass is dirtied with mud, the animals feeding on it are liable to be attacked with dangerous, if not fatal diseases.

If on land subjected to the triennial rotation with fallowing, and which is only manured once in nine years, the eighth crop division, or field intended for the production of the spring corn, being no longer in a state to be sown with advantage, is laid down to grass, it may be safely reckoned on as pasture ground, since the soil will contain a tolerably large share of nutritious principles.

The pasturage derived from fallow fields, which, in the triennial rotation with fallowing, received the tillage bestowed previous to the sowing of the autumnal corn, is more or less luxuriant and abundant according to the degree in which the soil is impoverished, or the amount of manure which it contained at the period when it was ploughed. The period for beginning to break up the fallow is, or ought to be, about the time of the feast of St. John; but some agriculturists find themselves compelled to postpone the ploughing until later, in order to avail themselves of the pasturage for a few weeks longer. It is seldom, however, that the farmer is obliged to make any alteration, on account of the rights which others hold over his land.

After it has been ploughed, there is no longer any pasturage left for horned cattle, although sheep may still find a scanty picking over it even after the second and third ploughings; but the operations of ploughing and harrowing follow each other too closely to allow of this source of nourishment proving of any importance. No dependence can, therefore, be placed upon the pasturage thus obtained, at least for more than six or seven weeks; and at the season when this is available, vegetation is most luxuriant.

If the soil is in good condition, and well adapted for the production of herbage, this kind of pasturage may be estimated at about one-third of the value of the fields laid down to grass in the system of alternate tillage and pasturage, during their first year of repose; but where the soil is impoverished, the land must not be estimated so highly, for lands which are frequently submitted to the action of the plough, produce less herbage than those which are laid down to grass for several successive years.

The pasturage on stubble fields, which commences immediately after the harvest has been got in, is more valuable on moist and badly tilled soils than it is upon those which are warm and well cultivated, and carefully freed from weeds, for the quantity of grass which grows upon the latter is but small. The principal advantage derived from them arises from the corn which falls upon them during the harvest: this corn is greedily eaten by pigs, sheep, and geese; which animals are, for this reason, the first that are turned upon the stubble fields. But this very circumstance renders the pasturage derived from stubble fields little adapted for horned cattle; it is only that derived from those parts which the other animals have left untouched, and where, in consequence, the grain which has fallen on the ground has germinated and produced young plants, which furnishes good pasturage to the larger cattle.

Among the various kinds of pasturage yielded by arable land, we must not forget to include that arising from the autumnal grain, both in the autumn season, as well as in the winter and spring.

This pasturage can only be derived in the autumn where the crops have been sown in good time, and have shot up with unusual vigour. It is more adapted for horned cattle than for sheep; indeed, some persons assert that it is injurious to sheep on account of its richness. This pasturage is, however, it must be remembered, only available on fields which are well drained, and even then only in dry weather. Under opposite circumstances, it is frequently productive of great mischief.

It is, on the contrary, most adapted for sheep during the winter and spring seasons. There are various opinions relative to the advantages which sheep derive from it, and also as to the propriety of deriving all possible benefit from it, or abandoning it altogether. While some farmers rely chiefly upon it for the winter pasturing of their cattle, others think that the pasturage thus obtained, besides being very uncertain in its amount, only serves to make the sheep dainty, and causes them to reject the dry fodder which is afterwards given to them in the stable; and, consequently, this variety in their food does more harm than good. In my opinion, it is those farmers whose chief object is to save their winter provender, who assign the greatest value to this kind of pasturage; while those who are fully aware of the advantages resulting from an abundant supply of dry fodder for sheep, either do not make any use of it, or attach a very trifling value to it.

We shall have occasion to recur to this question when we come to treat of the management of sheep. Still greater uncertainty exists with regard to the question whether or not this mode of feeding is injurious to the plants. Some agriculturists maintain that it is in the highest degree injurious; while others are of opinion that when adopted with proper caution, it is productive of good rather than harm. There cannot be a doubt that this mode of feeding cattle may be rendered exceedingly injurious to the corn. Several comparative experiments, conducted with the greatest care and attention, have tended to prove, that the crop may be diminished to less than one half the value of the seed; and even further, if this system be carried out to the fullest extent, and the land left to the mercy of shepherds and herdsmen, whose only object is to obtain as much food as possible for the animals under their care. But, on the other hand, these same experiments have proved that good rather than evil results from this mode of feeding, when it is conducted with proper care and attention, and the following regulations are observed.

This kind of pasturage should only be made use of from the period of the commencement of the severely cold weather until the end of February; and not then unless the ground is frozen hard. Whenever the sun shines warmly, it should be no longer used excepting in the early part of the morning, or so long as the surface of the ground remains unsoftened by the sun's rays, otherwise the feet of the animals will sink into the soil and damage the roots of the plants.

The soil must also be perfectly free from ice and snow; for when it is at all covered, the animals keep scraping with their feet in order to discover the plants, and thus injure them and pull them up by the roots; neither must the sheep be left upon the corn fields when they are covered with rime or hoar frost.

This kind of pasturage must never be attempted until the ground is well covered with the young plants; and on no account when they are only just beginning to show themselves.

Neither must it be resorted to at a more advanced season of the spring, or when vegetation has commenced, unless with very great circumspection, or in places where there is reason to fear that the crop will be too luxuriant, and that the grain, or the wheat especially, will be laid. In these cases, the animals may be suffered to graze upon the land to a later period of the spring, provided that the weather is dry. But this late pasturage must be used with great circumspection; and every point relating both to soil and temperature must be carefully taken into consideration. If all these points are attended to as they ought to be, it may be safely presumed that the dung of the sheep will restore to the soil quite as much nutritive matter as they take from it while grazing on the corn.

But where other persons besides the farmer hold a right over the land which entitles them to pasture their cattle upon it, the practice becomes highly injurious both to the land and to the crop; for the corn must then be abandoned to the shepherds to do as they please with it, and they care nothing at all about the interests of the proprietor.

When treating of the cultivation of meadow land in general, I spoke of pasturage upon meadows. In the spring this pasturage is very beneficial to and well adapted for sheep, while in the autumn it is more suitable for cattle. When the farmer himself uses the land for this purpose, so far from its being injurious to the meadow to employ it as pasture ground, the practice tends greatly to improve it.

If other persons have a right over this pasturage, that is, if it be held in vassallage, the point of the greatest importance is to determine how late in the spring the animals may be left on the land, and how early in the autumn they may return to it again. These periods are usually fixed by custom or old documents. A difference in the duration of the right of spring pasturage, be it ever so little either one way or the other, makes a considerable difference in the value of the land to the person who rents it, as well as to him who holds the right of pasturage; and it is this which gives so much importance to the question, whether the right of pasturage should be continued until the 1st of May, *old* or *new* style; for during the twelve intervening days between these two epochs, the cattle which feed upon the land will, if the weather be warm, find an abundance of food; but they impede the growth and development of the plants, and consequently have an injurious effect upon the quantity of hay yielded by the meadow. I have already stated the extent of time in which, during the spring, cattle may be pastured on meadow land with advantage to themselves and to the herbage.

Under the head of accessory pasture lands, we must first consider pasturage on wood-land. The value of this will depend not only upon the nature and situation of the soil, but also upon the kind, number, and magnitude of the trees with which it is covered.

The more completely the ground is covered with wood, the scantier and poorer will be the herbage it produces; consequently, the pasturage will be less valuable, both on account of there not being room enough for the cattle to graze, and also because the herbage which grows in the shade is not so rich or nutritious as grass growing in other situations. Even where the soil is very fertile, and the grass shoots up luxuriantly under the trees, it has so little flavour and is so little agreeable to cattle that those animals which are accustomed to be well fed never touch it until compelled to do so by hunger.

Pasturage on forest land is generally productive of more harm to the forest than good to the cattle. Many very valuable forests have been kept in a most miserable state of vegetation by being subjected to this system; the young shoots and branches being destroyed and the old trees considerably damaged. Nor is this pasturage productive of benefit to the cattle; so far from it, it often engenders disease.

Instances may indeed be found in which the trees are sufficiently advanced in their growth to prevent the pasturage of cattle there from injuring them, and therefore the farmer may avail himself of this pasture with advantage, the more especially as the trees afford an agreeable shelter to the animals during very hot weather. But these cases occur but seldom, and it rarely or never happens that the trees remain uninjured when others besides the owner of the land hold a right of pasturage over it. With regard to the influence which different kinds of wood have upon herbage, it may be observed that the grass growing under pine trees is dry and scanty; that under firs and larches more valuable. Very good grass usually springs up under the shade of oak trees; the same may be observed with regard to the herbage found under beech and birch trees, where they do not grow too close together. The most luxuriant and abundant pasturage is usually found under alders, but these trees grow only in low and damp places, and the herbage growing in such situations is always unwholesome, and prejudicial to the growth of trees; all plantations of alders should, therefore, be thick and close enough to prevent cattle from entering them.

To forest pasturage appertains the fattening of pigs upon acorns and beech-mast. This fattening of swine is designated, complete, three-quarter, half, and quarter fattening. The opinion generally entertained is that each of these proportions is realized once in six years, and that three times the produce is a mere nothing.

In countries where agriculture and cultivation generally are in a state of improvement, it is seldom, excepting under peculiar circumstances, which we shall immediately proceed to enumerate, that on farms of any size we meet with permanent pastures, or, in other words, land exclusively devoted to the growth of herbage.

The first exception is in places where the land produces such a plentiful supply of herbage as to make it valuable on that account, especially as the state of the locality, or the circumstances of the farm to which such land appertains, presents no more eligible means of turning the land to account.

The second is in places in which the raising of corn, and even the use of the soil as meadow land, is subject to many casualties in consequence of the frequency and danger of floods and inundations during the summer season.

The third exception is found on mountains and rapid declivities, where the nature and situation of the land and the climate would render it vain to endeavour to obtain any other kind of produce from it.

With the exception of these cases, almost all the land in cultivated countries which is held by individuals, is subjected to the plough, and devoted either entirely or at alternate periods to the growth of various kinds of grass. It is only in places where a community of possession, or a right of service, present obstacles to its being otherwise used, that good land which is worth the trouble of cultivation is still exclusively devoted to the production of herbage. And, in such cases, the pasturage obtained from the land is of very little value, for, generally speaking, none of the persons possessing a right over it concern themselves at all about improving or cultivating it.

The first of these three exceptions consists for the most part of pastures which, on account of the nutritious quality of the grass which it yields, is devoted to the fattening of cattle; for this reason such portions are designated *fattening pastures*, although they are often merely used for the grazing of milch cows and horses. The farmers who hold these pastures are perfectly aware that if the land was ploughed up and devoted to the production of the more valuable kinds of grain, it would yield a much larger return; but such pastures, as well as the nutritious matters which are contained in the soil, are usually regarded as heir-looms, which the farmer has received from his forefathers, and which he must transmit, as a sacred inheritance, to his descendants; and the man who dares to break one up, and appropriate to himself the advantages resulting from their tillage and cultivation, is looked upon as one who wantonly dissipates his own revenue and robs his heirs. An extraordinary amount of fertility is attributed to these old pasture grounds; and it is thought that if they were to be broken up and converted for a while into arable land, they would never regain their pristine fertility, even though they should appear to bear as luxuriant a crop of grass as before. It is allowed that they will again put forth high and strong grass, but it is thought that they never afterwards yield that thick fine herbage which they bore in their primitive state.

I shall not pretend to decide how far this opinion is or is not well founded, but I find that it is maintained by a number of talented and unprejudiced agriculturists. But I think that where it has been deemed impossible to restore a thick fine layer of grass, the failure has been attributable mainly to bad management: either the soil has been exhausted by being required to yield too great a number of crops, or else the attempt to restore it to the state of grass land has been badly conducted; perhaps the reproduction of grass has been left to nature only, in which case it will not be restored for a considerable period; or, again, the kinds of grass sown may not have been adapted for the production of thick, fine, close herbage, the reproduction of which is the object in view.

In many countries, the fattening pastures have been subjected to an alternate rotation adapted to their nature: the advantages thus derived from them have been very considerable; and during the years devoted to rest and pasturage, the produce yielded by them has supported a greater number of cattle than they were before capable of maintaining in two or three times that length of time.

To the second kind of pastures belong chiefly those situated near streams or rivers which are apt to swell and overflow their banks, or behind dykes or dams constructed for the purpose of retaining these water-courses in due bounds. These pastures, from being fertilized by inundations, are usually very rich and luxuriant. Their produce, and especially the pasturage to be derived from them, cannot always be depended upon; but in valleys, the arable land of which is situated on the elevated grounds, they are, and with justice, regarded as the basis of the whole establishment. Pastures situated on the sea coast are still more valuable, salted herbage and salt marshes being regarded as so exceedingly beneficial to cattle.

The third kind, or mountain pastures, usually yield a very abundant crop of aromatic herbage, which possesses properties favourable to the secretion of milk. They are, therefore, peculiarly adapted for milch cows, which, during the summer, are left to graze upon them both night and day, and frequently at a considerable distance from the dwelling of the farmer; and it is not until the approach of winter that these animals are taken up into the stalls. To this class belong the celebrated pastures situated on the Swiss Alps, as well as those of the Tyrol.

Other high grounds of difficult access which cannot be reached by the plough or by waggons, and producing thick but not strong grass, may be advantageously devoted to the feeding of sheep. In order to preserve to such pastures all their fertility, they should be suffered to retain all the dung deposited over them by the animals during the night. With the assistance of this amelioration, the pasturage will continue to improve; but without it, it gradually becomes impoverished and covered with moss.

It is seldom that we now find land, in the occupation of one individual only, which is constantly devoted to pasture, when, from its nature and situation, it is capable of being converted into arable land that will yield a fair amount of produce; for it has long been the opinion of most persons that land of this kind yields a greater profit when it has been constantly subjected to tillage, or when the action of the plough has been made to alternate with rest in the state of grass land. All the permanent pastures which we now meet with are commons or lands subject to certain privileges or liabilities which preclude the use of them for any other purpose. These common pastures are, for the most part, in a wretched condition, because every one is desirous of getting all he can out of them, and no one thinks of contributing to their cultivation or improvement. When they are easy of access, and particularly when situated in the neighbourhood of houses, they are used to excess at all times and seasons, and all kinds of cattle are turned on to them without any regard to proper order or succession. Under such management, they afford little more than exercise ground for the animals, yield a scanty crop of herbage, and soon become completely impoverished. It has long been a recognised fact that little or no advantage is to be derived from such land, and, consequently, the propriety of dividing it has been seen and acknowledged. In some cases those who held a right over the land have taken possession of it and tilled it, with the consent of all the other parties. Sometimes the landlord, and at others the lord of the manor, has taken upon himself the right of dividing this common ground among new tenants; and thus, during the last few centuries, the extent of common pasture land has become very much diminished. But, however advantageous this may appear to be to agriculture in general, it is nevertheless certain, that the diminution of pasture ground for cattle has been injurious to the cultivation of land, when the system or rotation under which the land is managed has not been altered to suit the change caused by this circumstance. It cannot be denied that in former times the generality of farms and agricultural establishments were better able to maintain themselves than they are at present.

Recent experiments made to test the success of the division of common pastures have tended to support this theory, so far, at least, as regards those cases in which, when the division was made, no new measures were taken as regarded the rotation by which the cultivation of the arable land was regulated. Each individual broke up the portion which fell to him in the division, and obtained from it as many crops as he could before it became exhausted. An increase of arable land demanded an increased supply of manure to ameliorate it;

instead of which the supply was decreased, in consequence of there being no means of making up for the portion of pasturage thus lost. The fertility of the arable land, and the quantity of produce yielded by it, therefore diminished in proportion as this land was increased in extent. Consequently, it behoves us to pause before we determine on dividing common pasture land into separate portions, without combining this division with that of the whole of the land, the suppression of all the liabilities by which the property is restricted, and the establishment of a new system or rotation, viz., either *alternate tillage and pasturage*, or the *stall-feeding* of cattle. Where this cannot be done, it is undoubtedly far better for the welfare of the community that the common pasture grounds should be retained, measures being, however, taken to improve their cultivation and to insure from them the greatest regular amount of produce that they can be made to yield.

The following are the principal regulations which must be attended to in the management of pasture land:—

They must be entirely freed from stagnant water which may exist in any part of them, rendering them marshy; for marshy and damp ground is very injurious to cattle of all sorts, and especially to sheep. The ditches and trenches—both those are intended to be permanent, and those which are only temporary—should always be kept open and in good repair.

If it be the object of the farmer to obtain the utmost possible amount of produce from their pastures, he must take care to destroy all the molehills.

Care must be taken to eradicate all the weeds, both those which are hurtful and poisonous, and those which take up a great deal of room, and prevent the growth of other and more useful plants. Thistles in particular multiply with great rapidity in rich pastures, for cattle will not touch them, and, consequently, their seed ripens and takes root. The cattle not only abstain from touching the thistles, but even abstain from eating the grass which grows around them. Pasture grounds may, therefore, frequently be seen completely covered with these noxious plants, and thus reduced to a comparatively useless state. This evil is, however, easily remedied; all that is requisite to be done is to cut down the thistles occasionally with a scythe, especially during the flowering season. When this is done several times following, these weeds will eventually disappear; besides, cattle will eat them after they have been laid on the ground and withered. In this manner the milk-thistle, henbane, and other noxious plants, may be eradicated. Finally, it is very advantageous to pastures to spread the dung voided by the cattle equally over them. If the dung be left undivided as it falls from the animals, the plants which it covers are at first completely stifled; but in the following year tufts of strong, coarse grass shoot up, which the cattle never touch, unless absolutely compelled to do so by hunger. But where the dung is properly divided and spread about, it produces a uniformly good effect on the vegetation, and that flavour which is so distasteful to cattle is scarcely perceptible. Shepherds are sometimes allowed to collect the dung voided by the cattle, and sell it; but by this means the pasture is deprived of a great portion of the nutrition which properly belongs to it, and, consequently, becomes impoverished.

In using pasture ground, it is, moreover, necessary not to crowd them with a greater number of cattle than it can properly and advantageously support. When too great a number of cattle are turned upon the pasture, vegetation is checked; the plants have not time to attain their full growth; the cattle bite off the tops of them, and then tear them up by the roots. On the other hand, it is equally injurious to a pasture for too small a number of cattle to be turned on it to graze. The effect of this is not only to diminish the utility of the pasture and the return that it yields, but tends to impoverish it. Under such circumstances, the herbage shoots up in great luxuriance, and many plants appear which the cattle will not eat after they have attained any height. These plants become strong and multiply; while the finer kinds of herbage, those best adapted for pasturage, disappear. Besides, if the pasture be not supplied with a proper number of cattle, it does not receive as much manure as it ought to have.*

For the same reason, the cattle must not be turned in to the pastures too early in the year, or kept there too late.

It is certainly advantageous to pastures to remove the cattle from them now and then, in order that the grass may have time to recover itself. It is for this reason, that in the best conducted agricultural establishments, and those in which pasturage on the arable land forms a constituent, if not an important part of the rotation, the pasture ground is divided into separate parts. Under such an arrangement, the animals which require the most succulent and nourishing food are first turned on to each separate division; and, after they are removed, the other kinds which need a smaller quantity of nutriment are turned on to it. By this means the whole of the grass is eaten off close to the ground, and thus those plants which the cattle are least partial to are not able to grow. The herbage is then left to recover itself for a sufficient time, and afterwards the first herd is again allowed to feed upon it.

The succession, association, or separation of the various kinds of cattle upon pasture land, is in a great measure regulated by local circumstances.

In the spring, the best pasturage is often given to the ewes, because these animals stand most in need of it to increase their supply of milk, and give them strength to nurse their lambs. If the winter stall-feeding of the large cattle can be prolonged until late in the spring, it will be rather advantageous than otherwise. For experience shows that herbage always grows most thickly when sheep have been suffered to graze upon it early in

* When the pasture is large in proportion to the number of cattle which graze upon it, and is not divided into separate parts by fences, the animals wander all over it, and destroy more herbage with their feet than they consume. By this means the vegetation is always checked. This inconvenience does not exist to so great an extent where the number of cattle is properly proportioned to the size of the pasture, or where it is divided so that as soon as they have grazed off one part they may be removed to another.

the spring; but they must not be left too long upon the pasture, and at least three weeks must be allowed to elapse before the larger cattle are turned on to it. By such mode of treatment, the grass will have time to recover itself; and the smell of the dung, which the sheep have left on the ground—a smell exceedingly unpleasant to cattle—will have time to become dissipated. If, in the after part of the season, sheep and cattle are alternately turned upon the pastures, the same interval of time, viz., three weeks, must always be left between the occupation of the pasture by the one and the other.

It is not only upon badly managed pastures in which poverty and disorder are apparent, that sheep and horses are seen grazing by the side of cattle, but the same may frequently be observed on rich fattening pastures. It is a generally received opinion, that the grass which is too coarse and hard for cattle, and especially that which springs up in places where the dung has formerly fallen, cannot be consumed with greater advantage than by mixing horses with large cattle; while the very fine herbage, which the cattle cannot lay hold of with their teeth, is peculiarly adapted for sheep. As it is always deemed advisable that the grass should be eaten off close and uniformly, it is necessary thus to mix the kinds of animals on it; and where this has been done with due care, after a certain time the herbage shoots up again with increased luxuriance and thickness.

Some farmers, however, do not approve of the practice of turning horses on to the pastures before the cattle are removed, but let cattle, horses, and sheep succeed each other, and then leave the pasture alone to recruit itself.

The division of pasture land into separate portions, whether these portions are close together or situated at considerable distances from each other, and the practice of successively turning the different kinds of cattle on to these divisions, and then leaving the herbage to recover itself, is a system which possesses decided advantages over the practice of suffering the cattle to wander over the whole extent of pasture ground. Cattle which are always confined in small spaces, do not spoil so great a portion of the herbage with their feet as they would if they had more space to graze over. The grass is, consequently, uniformly eaten off from the whole of the ground, and then left to recover itself. But where the cattle are allowed to roam over a large extent of pasturage, some parts remain untouched, and there the grass grows old and hard; while, from others, the herbage is cropped so close that it can scarcely shoot up again. Cattle are more quiet in confined pastures, and quietness is highly advantageous to them.

In many countries, where pasturage forms part of the system or rotation, the pasture ground is divided into small enclosures, each of which receives a number of animals proportionate to its size; care being taken that the animals placed together shall be of about the same size and strength, and such as are accustomed to be together.

Great value is, consequently, set upon small enclosures bounded by hedges, because considerable importance is attached to the shelter which these hedges afford to the animals from wind, from excessive heat, from the rays of the sun, and likewise to the greater degree of quiet which cattle enjoy in a space thus enclosed.

Good watering places are essential requisites in all pastures. The ponds or reservoirs, in which the drainage from springs and ditches is collected, afford but a poor resource to the cattle. Therefore, where there are no natural watering places, artificial ones must be constructed. These should be dug in situations where the water is disposed to collect, and to which that contained in the ditches can be conducted. They should never be placed close to the ditches, nor should these latter be enlarged for the purpose of bringing them near to the reservoir; for the edges of the ditches would, in that case, be spoiled and broken by the feet of the cattle, and they, themselves, choked with mud. The best way is, to conduct the water into the pond or reservoir through a ditch or trench intended for that purpose. These ponds, or watering places, should be at least seven feet deep in the centre, and should slope gradually from the brink to this depth. Their circumference should be in proportion to the number of cattle for whose use they are intended: the mean diameter is usually about sixty feet.

When the soil is of a plastic nature, and especially if it be at all argillaceous, these ponds will retain the water very well; but if the soil is sandy, or contains beds of sand, which may admit of the water leaking out, it will not be sufficient to coat the reservoir with clay, as this is liable to crack; but the bottom must be covered with mortar made from lime, in the following manner:—The surface having been well smoothed and beaten, must be covered with a layer of recently slacked lime, two or three inches deep, sifted and moistened with water, until it becomes of the consistence of cream; on this must be laid a stratum of clay about six inches thick. This clay should then be beaten until it becomes as firm and hard as a paved floor.

SECTION V.

ON THE REPRODUCTION OF ANIMAL AND VEGETABLE SUBSTANCES.

Reproduction and manufacture are usually considered as somewhat synonymous terms; but we are of opinion that, whether viewed in a physical light, or with relation to general economy and art, these two things are so completely opposed to each other, that the principles which are applicable to the one are altogether foreign to the other; and, consequently, the agriculturist, the manufacturer, and the political economist must each be guided in their various operations by totally opposite rules and maxims.

There cannot be a doubt that these two things are of entirely opposite natures, and that each of them have certain peculiarities which appertain solely to it; but these peculiarities are not so widely different as some persons have pretended. In fact, those differences which have most frequently been pointed out, will be found, when we come to inquire into their fundamental principles, to have but little foundation. It will not, therefore, be foreign to our present purpose here to say a few words respecting the analogy of these two modes of procuring matter, as well as on their differences.

The principles and rules which have been adopted as those best calculated to ensure success in the economy of manufactures, have already been entered into and explained; they may serve as a guide to the economy of reproduction, if, from the resemblance between the latter and manufacture, there is any possibility of the same rules being applied to each of them. Some have asserted that the essential difference between manufacture and reproduction is, that the former gives an unusual form to matter, whereas the latter produces fresh matter itself.

But reproduction is not a creation, or formation of some substance made without matter. The elements for the formation, growth, and accomplishment or maturing of the plant or animal ought to exist first of all. Whoever wishes to ensure reproduction, must, like the manufacturer, procure the elements to work on; in many cases he must seek for them, and even give them an artificial preparation. Reproduction, as also fabrication, can only be made to take place with the assistance of substances which already exist, which become decomposed from their original elements, and are thus prepared to assume new forms.

It is said that formation is brought about in reproduction simply by the force of nature, while in manufacture the effect is produced by art and the power of man. But in this latter case man acts only by employing the force of nature, without the co-operation of which he can obtain but very few of the usual products of manufacture. In most cases, it is true that he directs that force, in a greater or less degree, according to his own will; but there are many existing circumstances under which he is compelled to leave nature to act entirely according to her own laws. This is the case in all those manufactories which are compelled to have recourse to chemical processes, as colour makers, wine and brandy distilleries, breweries, &c.; operations in each of which we can only moderate, and endeavour to regulate the natural action which substances have upon each other.*

* As we have in another place had occasion to remark, "No branch of chemistry is more interesting, even to the general reader, than that which relates to the vegetable world; for objects of the highest interest here present themselves in all directions. The finger of God seems evident in every plant we chemically examine. Thus, their juices, which are always so regular and so

Is it, then, to be understood that nature operates more powerfully in reproduction than in manufactures? Undoubtedly, if nature has only to supply the wants and necessities of a small extent of surface. In a thinly populated country nature can often produce sufficient, if we take into account all the collective produce of the soil, as well as the game found upon it, to supply the wants

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uniform—so sweet in some, so bitter or acid in others; tasteless in many, yet saline in several—the order and the regularity are alike incomprehensible to us. Neither by any contrivance of ours can this regulated order of things be altered. For instance, the wild sorrel still secretes its acid, if nourished with only sugar and water; the sea-kale, which grows wild on the sea shore, will yet secrete in its juices common salt, when growing on our most inland gardens. Neither can a plant be made to absorb one salt in preference to another. If a sprig of mint is placed in a solution of various salts, it will absorb some, but entirely reject others.

The power which the plant thus exercises is to the chemist utterly unknown. To effect the same separation of the salts when dissolved together in water, the chemical analyst has to perform a series of decompositions, and other chemical operations, before the desired result can be obtained, a process which the sprig of mint performs at once. The reader must not suppose that this is the effect of mere filtration, for the most delicate filters are utterly useless in any attempt to separate a salt from its solution. Then, again, certain plants show a decided preference for, and absorb only, particular salts. The nettle and the sun-flower, for instance, saltpetre (nitrate of potash), clover, gypsum (sulphate of lime). And these absorbent powers of the plant are not confined to soluble substances, alumina, manganese, phosphate of lime, &c., which are not dissolved by water, abound in plants. And moreover, the required substance seems always placed, by some magical and unerring arrangement, in the very part of the vegetable where its presence is most needed. Thus flint (silex) abounds in the straw of wheat, where its presence helps to impart the requisite degree of firmness to enable it to support the loaded ear; but it is found in a very diminished proportion in the seed, where it is not required. Is not this the contrivance of its Divine Author?—or is all this arrangement also chance? The progress of chemistry continually unfolds many a beautiful vegetable phenomenon just as mystic, just as astonishing as any of these, and the field is not yet nearly exhausted; but still the conclusion the chemist arrives at is the same. The deeper he penetrates, the more numerous are the contrivances he observes, and more clearly manifested become the works of the Creator. Examine as another instance of these mysteries merely a cubic inch of soil, composed at most of only four simple earths, and notice the discordant nature of the chemical ingredients so uniformly and so regularly produced by the different plants which that soil produces with only the aid of water, and the atmospheric gases. Observe the wheat producing its flour; the sorrel its oxalic acid; the beet its sugar; the poppy its opium. From one plant comes the fragrance of the rose; from another the odour of the garlic. Dr. Thomson thought of these things when he observed ("System of Chem." vol. iv. p. 303): —"The multiplicity of operations continually going on in vegetables at the same time, and the variety of different and even opposite substances formed out of the same ingredients, and almost at the same place, astonish and confound us. The order, too, and the skill with which everything is conducted are no less surprising. No two operations clash. There is no discord, no irregularity, no disturbance. Every object is gained, and everything is ready for its intended purpose."

of the wandering and isolated hordes who seek their subsistence there; but this is only the case in those salubrious and fertilizing climates where the human species first originated. After man had been expelled from paradise, he had, as the human race spread and multiplied upon the earth, to struggle with thistles and thorns, and to eat bread earned by the sweat of his brow, or, in other words, to have recourse to labour and art, in order to satisfy his wants: he had to procure from that highly favoured spot and its environs, not only the most nourishing kinds of grain and vegetables, but also those domestic animals of which he stood in need, and to devote all his care and art to the naturalizing both of plants and animals in the new locality which he had chosen for himself. By degrees, as his necessities and his family increased, his faculties developed, and art and labour were rendered more requisite; so that at this period among civilized people, the share that labour and art had in the production of the mass of natural products, when compared with that which may be attributed to nature, is not assuredly less than that which may be attributed to them in the preparation of manufactured articles. This fact contradicts the assertion which attributes to art and science a greater share in manufactures than it has in agriculture.

By degrees, as reproduction augments in quantity and value, the man whose object it is to induce it, will have to submit to the same rules and laws as the manufacturer. However extraordinary, therefore, some persons may consider the theory which leads me to consider the soil as the agriculturist's primitive matter; at any rate, if it be wished to place agriculture and manufactures in opposition to each other, I cannot renounce it, since, in my opinion, numerous and very important consequences result from this theory, not only as regards the development of industry, but also of political economy.

We approach nearer to the point of separation between manufacturers and reproduction, when we say, that with the assistance of science and labour the former represents the object under that form which has been designed for it, and according to some previously determined plan; while, on the contrary, he who induces reproduction is subjected to those forms from which nature seldom or never varies, and although he may choose between them, he can never alter them. But even this is by no means an exact definition, for certain manufactures are equally subjected to the forms prescribed by nature, as for example, the manufacture of salt, and, in fact, all those in which crystalization takes place, or where chemical processes are employed. In such manufactures the form can only be modified, and this not precisely in accordance with the will of the manufacturer, but more in accordance with the action and processes of nature.

This difference is more clearly defined under physical relations, when the agents employed by reproduction are seeds and germs, and when it is entirely subjected to the force of nature, and the matter brought forth under the form with which nature has endowed it; for every product, be it animal or vegetable, is derived from a germ, although the auxiliaries favourable to its development, and the elements required for nourishing it, fostering its growth, and bringing it to maturity, are for the most part furnished by art.

But, although the creation itself and the form under which it appears is essentially due to the germ contained in the seed, art is not entirely without its influence upon it, seeing that in many cases it may modify it by coupling together individuals of different species or breeds: this observation, however, applies rather to animal than vegetable reproduction.

VEGETABLE REPRODUCTION.

All the most perfect plants, the only ones which we shall have occasion to refer to, owe their existence, in the first place, to the seed formed by germination.

That reproduction in which the seed is the chief, if not sole agent, is not only the most primitive, but the most ordinary; it is that, therefore, of which I shall generally have to speak, deferring any mention of the other kinds of reproduction until I come to speak of those plants to which it relates.

It is of the utmost importance that the seeds of all kinds of plants should have attained to perfect maturity, and should have been carefully and healthily preserved.

Seed which has not reached maturity may, it is true, possess the power of germinating, but it always retains a disposition to disease and weakness. It is true that disposition may be so far conquered by a coincidence of favourable auspices, and by a soil and temperature peculiarly adapted to the nature of the plant, that imperfect seeds do occasionally produce vigorous and healthy plants; but there is always great danger of the crops failing, and the saving which the agriculturist may have effected by using such seed is not commensurate with the risk. I think it the more necessary to lay particular stress upon this point, as Mr. Banks, the great English naturalist, has, in his observations on the causes of corn being laid, stated it to be his opinion that the grain of corn which has been laid is equally as good for seed as any other, since it has not lost the power of germinating. This opinion, promulgated by so celebrated a man, which might have spread itself extensively and produced the most baneful effects, was soon contradicted by the experience of numerous agriculturists. Although some agricultural authors may have recommended that the smallest grain should be selected for the purpose of being sown, because then a given measure will contain a greater number of seeds, all practical men who have paid any attention to the subject are not the less convinced of the advantages arising from sowing the largest and most perfect grains; and it frequently happens that by strictly adhering to this plan they have obtained particularly good and very marked results, and a stronger and healthier race of plants have been created, which a little care has afterwards been sufficient to preserve. It is this which partly accounts for the advantages which are found to arise from sowing the different kinds of grain procured from abroad, where proper care has been employed in their selection. In choosing the seed, a preference ought to be given to that portion of the grain which has been grown upon a soil favourable to it, and calculated to bring it to perfection; and it is worth while, on more accounts than one, to take the trouble of gathering the seed from a field suited to the plant, and also to pay all possible attention to the harvest by weeding and isolating the plants during their vegetation and hoeing up the earth, and, in short, sparing no care or pains likely to be conducive to the perfecting of the crop. By these means we shall ensure the seeds becoming completely and uniformly matured. But where it is one of the distinctive properties or peculiarities of the plant for the seed to ripen unequally, those ears or pods should be set apart for the purpose of sowing which are perfectly ripe.

The next point of importance is the preserving of the seed or grain intended for sowing. It ought to be carefully kept from damp: not only the moisture inherent in it, but also that portion which it may absorb, should, if possible, be abstracted from it; in order to effect this, it must be spread out to dry, and frequently turned, until the moisture is all evaporated. For as soon as the seed begins to deteriorate, which state is often expressed by saying that it is heated, and which becomes apparent in a very unequivocal manner from the odour which such grain then exhales, its success when sown will be very uncertain. But such seed has not lost the power of germinating: the young plants which shoot from it very frequently look fresh and green, but as they develop themselves, especially when they begin to blossom, they become weak and sickly, and the flowers fall off without fecundation taking place, or, at any rate, when little or no grain is formed. I have had opportunities of witnessing the truth of this statement in a crop of oats produced by grain which had been allowed to become heated. The effect will be more or less striking in proportion to the deterioration of the grain, but it will in all cases be perceptible; and, very frequently, when we attribute the ill success of the crops to other causes, this is the actual one.

Many persons consider a frequent change or renewal of the seed as an indispensable condition to the production of a fine crop. The necessity of this change is insisted on both by theorists and practical men, especially in extensive agricultural undertakings, where the great object is to produce the largest possible amount of matter. But, according to my own conviction, the strength of which has been rather increased than diminished, in proportion as I have acquired new data, the advantage derived from the use of seeds procured from foreign sources arises solely from this cause, viz., that farmers are not in general sufficiently careful in the choice and preservation of the seeds which they have gathered themselves. It may occasionally depend upon locality, or upon the nature of the soil and climate not being favourable to the perfect formation of certain kinds of grain, and in that case recourse must be had to seed procured from elsewhere. But it more frequently happens that the amount of labour required by the farm or agricultural undertaking does not admit of the farmer's being able to devote the necessary care and attention to the grain intended for seed; hence it is often injudiciously selected, and suffered to experience fermentation, which deteriorates from its value and healthfulness. In all countries there are some districts and some particular farms which are famous for producing certain kinds of grain, and where the whole harvest is frequently sold for seed at very high prices. In such localities we generally find that this advantage arises not less from the nature and properties of the soil being favourable to the production of one particular kind of grain, than to the infinitely greater care and attention which is paid to the crop; and we shall also find, even among the farmers themselves, a conviction that they owe the reputation their seeds enjoy as much to the latter as to the former circumstance.

In places where one or both of these advantages are not attainable, it may undoubtedly be advantageous to procure the seed from elsewhere, even though this can only be done at great expense; but I am by no means an advocate for the absolute necessity of this mode of proceeding, for I am convinced that if the soil be in other respects favourable, any kind of seed which is at first imperfect will gradually improve in quality, and, with care and attention, eventually be rendered perfect.

Persons who maintain that a renewal or change of seed is absolutely necessary, inquire whether it ought to be taken from a richer or poorer, a stronger or lighter soil, and from a milder or colder climate. My reply is, procure it from that place where it is most perfect and healthy. This is not always where the soil is richest, or the climate the mildest; as in such places the corn is often too thick on the ground, and consequently not sufficiently exposed to the influence of air and light to allow the grain to acquire absolute perfection; besides, the seed or grain is often too large, and there is more husk than farina in its component parts, the latter of which is alone capable of affording nutriment to the young plants. In those places, on the other hand, where the soil is so weak that it is incapable of furnishing sufficient nourishment to effect the complete formation of the grain, that grain will be equally improper for the reproduction of other plants; for wheat grown upon a soil which only produces stunted grain will always bear an imperfect seed, and will require to be replaced by seed derived from really good wheat land.

It is a well known fact that, in plants as in animals, strength and weakness, health or disease, are transmitted not only to the first generation, but through several succeeding ones; and that these dispositions can only be gradually eradicated by the help of other influences.

A change of seed is never entirely successful unless managed with great circumspection. Great care must be taken to see that the grain which is to be sown is perfectly free from the seeds of weeds, otherwise we shall incur the danger of introducing into our fields some useless or even injurious plant which had not previously existed there, as, for example, the golden daisy or corn chrysanthemum (*chrysanthemum segetum*).

If there be no means of separating the grain from certain seeds of weeds, that may be considered as a motive for procuring the former from some other place where these pernicious seeds do not exist. Thus, in my neighbourhood, they often change the barley and oats grown on the hills for those raised on the low lands, because, in the latter, those kinds of grain are found mixed with field mustard, which weed does not thrive on high lands; while, on the higher grounds, the oats and barley are found intermingled with wild horse-radish, which weed can easily be extirpated from the low grounds.

Some seeds retain their germinating power for a considerable period, provided only that they are carefully preserved; while others, on the contrary, lose it quickly, and can hardly retain it for the space of a year. If we come to examine which are the seeds that retain their vitality for the greatest length of time, we shall find it is always the most perfect ones, and that the imperfect and sickly ones lose their power of germinating first. To this fact is to be principally attributed the advantage of old seed over new in several kinds of plants. Vegetables and plants can only be procreated by perfect and healthful germs, which have not been deprived of their necessary space and nourishment during their growth by abortive plants which will never come to maturity, and which come from a crop free from those diseases the germ of which lies in the grain, as is the case with smut, mildew, &c. But if we would fully understand this point, we must make ourselves perfectly acquainted with the nature of each particular kind of plant or vegetable. Grain which has become perfectly matured may be preserved for a very long time. Stores of grain are known to have been preserved from time immemorial in caves hewn in solid rocks, which have been discovered by chance, and the contents of which have still proved to be good for seed. This could not, however, in all probability, have been the case had not the grain been totally secluded from the influence of light, air, and moisture. In general, grain does not keep for any great length of time; some persons, however, assert that they have found wheat that had been kept five years, and rye three years old, to be fit for vegetation. Wheat of only one or two years old is almost universally preferred, as being less liable to disease. Most agriculturists are of a different opinion as regards rye, and prefer quite new grain; for when it is more than a year old they consider it necessary to sow it more thickly than they would in the former case; and, consequently, an equal measure of seed would sow a smaller extent of ground in the former than in the latter case.

The seed of most vegetables keeps good for a considerable period. I have not been able to perceive any deterioration in the seed of vetches when eight and ten years old. All kinds of seed which yield oil keep for a very many years, provided the worm does not get into them: old linseed is far preferable to new; while, on the other hand, new hemp-seed is considered better than old. According to my own experience, clover-seed keeps very well for two years; it deteriorates on the third, and becomes quite feeble and incapable of producing plants on the fourth. I have succeeded in raising good crops of spurrey (*spergula*) from seed seven years old. The properties of each kind of seed employed in agriculture can, however, only be developed by new experiments, and by a collection and recapitulation of those which have already been made. As almost all the best kinds of seed keep at least until the second year, it is always advantageous to have a larger stock in hand than will be required for one year's consumption, especially of autumnal grain, as by this means the farmer is enabled to choose the most favourable period for sowing his land. It must not, however, be understood, that we mean to advocate the practice of saving the grain of those years in which the crops have not become properly matured; for then, as has already been stated, it is not fit for seed.

But if, when such years occur, the farmer happens to possess a store of seed left from the preceding year, he may consider himself very fortunate.

It is of the utmost importance that the grain should be carefully separated from all those seeds of weeds which may be mixed with it, as well as from all the imperfect grains which may exist. This may be effected—

1stly. By winnowing the seed, or throwing it into the air (as is the practice in some countries, in order to separate the grain from the husk and the dust); the grain which has fallen furthest off is then chosen for seed. This operation may also be performed by means of a ventilator, or a kind of mill which separates the heavier from the lighter grain, and from the seeds of weeds.

2ndly. By means of sieves, of which we must have a variety, pierced through with holes of all sizes; the seed of weeds is smaller than grain, and all the little abortive grains fall through the sieve, while all that is properly developed is retained. Seeds of a different class, and which are larger than the grain, must subsequently be separated from the latter, by means of other sieves which retain the grain.

3rdly. By washing, throwing the seed into vats filled with water, in which they are afterwards stirred about. All the heterogeneous matter, as well as those light grains which swim on the surface, are then removed. This is by far the best way of getting rid of the seed of the wild mustard (*sinapis*), and that of several other weeds. Immediately after this operation, all the grain which has been immersed must be spread out to dry, if we would not have it sustain any damage.

This process must not be confounded with the practice of moistening the seeds, and then keeping them in a state of humidity, in order to accelerate the germination of them, and then burying them; this practice has long existed among gardeners. It has also been recommended that this mode of proceeding should be applied to arable land, especially when, at the sowing season, the earth is extremely dry. But I cannot deny that, in my opinion, it is particularly at this period that such a practice would be fraught with most danger; for, if the drought should continue after all the moisture has evaporated, or been absorbed from the germinating seed, this latter, or the young plant it has produced, must necessarily become parched and die; therefore, it is far better for the seed to remain in the earth without germinating, until sufficient rain falls to impregnate it with moisture, and call forth its vitality. It is true, that where moisture comes opportunely, the above plan may prove successful; for the seeds will germinate and shoot up much more rapidly than they would have done had they been put into the earth dry; but the advantage is not sufficiently great to counterbalance the risk; at all events, recourse should only be had to this practice when the sowing has been so much retarded, that there is no longer any danger of the earth becoming so dry as to parch the seed.

Divers methods of heating or swelling the seeds have also been recommended, for the purpose of accelerating and strengthening the process of germination. We shall speak elsewhere of those, the object of which is to preserve the grain from smut and other diseases; at present we shall only occupy ourselves with those means which have for their object the stimulating or strengthening the principle of vegetation.

(*a*). The drainage from dung-hills, lime water, wood-ash water, salt water, &c., these being considered as active manures which place the young plants in direct contact with aliments peculiarly adapted to their nature, tend to accelerate vegetation, and give to these plants sufficient vigour to enable them advantageously to combat the injurious action of whatever may be around them. But theory and unprejudiced experiments combine to demonstrate the inefficacy of manure which immediately surrounds the seed; for the young plant first derives its nourishment from the seed grain itself; and when it begins to seek nourishment through the medium of its roots, the ramifications of these latter shoot out too far to admit of their receiving any nutriment from the substances which immediately surround the husk of the seed. These manures, when thus applied, are therefore productive of little or no effect, their quantity being too insignificant to produce any sensible effect upon the soil.

(*b*). Some persons have also recommended for this purpose divers substances which contain oxygen, and even some acids, particularly oxygenated muriatic acid, sulphuric acid, cinnabur and other oxides of lead, sulphate of iron (green copperas), nitre (saltpetre), nitric acid, sulphuric acid, and arsenic. Many of these substances have been used for a considerable period, long before it was discovered that oxygen and those matters which from being surcharged with that acid easily separate from it, act as violent stimulants on the germinating properties of seeds; since that discovery, the attention of many scientific men has been directed to this point. However incontestible the fact may be, that oxygen possesses the faculty of accelerating vegetation, many carefully-conducted experiments have shewn, that this excessive stimulation of the germ of the young plant is far from being productive of benefit, but rather tends to predispose the plant to weakness and disease.

Both theory and experience incline us, therefore, no longer to advise the employment of these means, and especially as it is difficult to ascertain to what extent they may be used, and how they may be employed on an extensive scale so that each seed shall receive its due proportion.

Several agriculturists have endeavoured by the use of these substances to keep off and destroy insects and birds; but the common steeps of this nature do not produce the desired effect; and it is dangerous to employ poisonous ones, particularly such as contain arsenic in sufficiently powerful proportions to ensure the attainment of the desired object.

Each separate kind of grain has a certain period of time, longer or shorter, during which it ought to lay in the earth in order fully to develop itself and ensure its producing perfect plants. The success of the crop very often depends entirely on a favourable time being chosen for placing the seed in the ground. But as the success of this choice depends upon the state of the weather and temperature during the period of vegetation, the farmer will never be able with certainty to determine the best time for getting the seed into the ground. He must be chiefly guided by the dryness or humidity of the air and of the soil, and thus endeavour to select that state which he knows to be most favourable to each kind of grain. Rye, barley, and buck-wheat require a dry and warm soil to favour their first germination; others, on the contrary, as wheat and oats, require more moisture. Much is already gained if only in this respect the favourable moment has been seized; and there will be a far more reasonable hope of the harvest being successful when the sowing has taken place under such favourable auspices, than there ever can be when it has been performed under different circumstances. It has often been remarked that certain states of the weather and of temperature are particularly propitious to the operation of sowing. In the spring, when the atmosphere is loaded with fogs, which, particularly at sunrise and early in the morning, give to the boundaries of the horizon an apparently undulatory motion, so that the rising sun appears, in the language of the people, "to dance." When this is the case, large barley may be sown with peculiar advantage. Many agriculturists attribute great advantages to the seed being brought in contact with the dew, and, consequently, recommend that the sowing should be performed towards evening, and the seed not covered until the following morning; but this can only be managed when the nights are warm. If there is any danger of white frost coming on, the seed must be covered at once.

Many agriculturists give it as their decided opinion that the seed should be got into the ground at the earliest period at which the operation can be performed, and as quickly as possible. But by acting up to this maxim in the fullest extent of its meaning, we shall run the risk of sustaining great loss, especially if we neglect those considerations which have reference to the state of the soil and the temperature. In all cases, however, everything should be kept in readiness to embrace the first favourable moment. The English have a saying, "You had better be out of temper than out of season." What is chiefly to be avoided is the neglecting a suitable amount of preparation from a desire to sow early.

Formerly the moon was supposed greatly to influence the period of sowing; certain seeds were to be put into the earth during the moon's increase, others during its decrease. The rules appertaining to this theory had almost been forgotten, when a skilful and experienced American gardener revived them by relating his own experience and experiments, and he brought over several Englishmen to his opinion. A natural philosopher seeks to explain the influence of the moon, by saying that the uninterrupted action of light which takes place when the moon shines throughout the whole night may possibly be injurious to plants during their period of germination, since it is a well-known fact that light is not favourable to plants which are in this state. It will be advisable to wait until this system is confirmed by a greater number of facts and experiments before we allow ourselves to be at all influenced by it.

Each kind of seed ought only to have a covering of earth of such a depth as is suitable to its nature. So long as this depth is not exceeded, there is no doubt but that the seed will shoot the better for being placed at a considerable depth below the surface, because it there finds the necessary moisture, and the young shoots which are given off from its roots, run less risk of being parched, deprived of earth, or destroyed by frost. But too thick a covering might very possibly entirely prevent the germination, or, at any rate, present too great an obstacle to the putting forth of the seminal leaves. As a general principle it may be admitted that the larger the seed, the thicker is the covering it can bear; while very fine seeds will only bear a light covering of earth.

There are three methods of covering up the seed in agricultural operations:

1. By sowing under furrows, and burying the seed by ploughing.

2. By sowing upon furrows, and burying the seed with a harrow.

3. By sowing in land which has been ploughed and harrowed, and burying the seed by a second harrowing, or by passing a roller over it.

And to these we may add a fourth, viz.:—

4. By burying the seed with a drill, or some machine of the kind.

The depth at which the seed ought to be buried, and the choice of the manner of covering it, depend as much upon the actual nature of the seed, as upon the state of the soil and temperature. All kinds of seed require to be more covered in dry than in moist seasons. We must allow ourselves to be guided by this fact; carefully, however, avoiding all extremes, as it is possible that the temperature may change immediately after the seed has been sown; and then, if heavy showers should happen to fall, those seeds which have been placed deep in the earth will be very likely to be smothered. The drill, or a similar machine, is the best instrument which can be made use of for covering the seed, because it enables us at once promptly and securely to sow to a greater or less depth as seems best. In the course of this chapter we will consider the nature of each kind of seed. For the present we shall merely observe, that among the seeds in most general use, vegetables, wheat, barley, and oats require to be well covered; while rye and buck-wheat, on the contrary, do not admit of being placed so deep in the earth: there is always great danger in sowing the latter under furrows when there is any possibility of wet weather ensuing.

Some agriculturists have, in order that they may proceed with more certainty, adopted the practice of burying one half their seed under, and sowing the other upon the furrow. I do not consider that it is of much consequence as regards autumnal sowing, whether or not this method is employed; and it may often prove beneficial to the agriculturist to act upon it, especially if he is not inclined to devote much manual labour to the operation. But when it is applied to the spring sowing, the most deplorable results have ensued, because by means of it the seed is divided into two portions in point of vegetation, and this difference is perceptible even up to the period of its attaining full maturity.

It is always necessary to pay very great attention to the sowing of small seeds, such as clover-seed, for they may when covered by harrowing easily become too deeply embedded in the earth; not but that they require to be well surrounded with mould to ensure their germination, unless the weather happens to be extremely favourable. We shall return to the consideration of this subject when we come to speak of the cultivation of each kind of produce separately.

Of all the questions relating to this point, the most difficult to solve are those of the average depth at which to sow, the quantity of seed which ought te be put into the earth, and where the ground should be sown thickly and where scantily. As the expressions "to sow thickly" or "scantily" are absolutely relative, we must first of all determine what we mean by them; and this is not difficult, since we find a very great uniformity of opinion in almost all nations and climates respecting the quota of seed which ought to be sown on a given space.* The medium quantity is, if we reduce the land and the seed to our measure, between eighteen and twenty *metzen* of Berlin† per acre; this measure applies to every kind of

* Here our excellent author is in error: such an uniformity does not exist. The quantity of seed which I have seen used, and have myself allowed for a given space on my lands in Italy, is but exactly the half of what is ordinarily used on the borders of the Lake of Geneva.—FRENCH TRANS.

† A "metzen" is 100 English quarters.

grain but oats, which are usually sown one-quarter or one-half less thickly.*

If there were any means of spreading the seed uniformly over the land, and each grain produced a plant, such a quantity of seed would be excessive. Count Podevil, in his account of his agricultural experiments, has calculated, that where this quantity of seed is used, each square foot of ground receives ninety-one grains of rye; and states, that on examining one of the thickest covered portions of the field, he has found only thirty-two plants growing. It appears to me impossible that even that number could attain to maturity, for there could not be sufficient room or nourishment for them on so small a space; at any rate they would put forth no suckers, nor would each plant produce more than one ear. I have often observed that in very fine corn crops, where the ears were large and full, although not sufficiently so to cause them to be laid, and which have yielded a produce far exceeding that which might be expected from the fruitfulness of the soil, there were not more than five or six

* The proportion of seed requisite for different crops and different soils, the advantages of changing the seed, and of varying the ordinary quantity employed, are all themes to which considerable and lengthened attention might be profitably devoted by the farmer. We have little doubt that on many soils the proportion of seed usually applied for the cereal grasses might be profitably diminished one-half. There is a very excellent pamphlet by Mr. Hewitt Davis, on "the advantages of diminishing the quantity of seed," which the farmer may consult with advantage. The following table gives the ordinary proportions employed in England (*Johnson's Farmers' Encyclopædia*):—

	Time of Sowing.	Broadcast.	Drill.	Dibbler.
Wheat	Sept to Dec.	2½ to 3½ bush.	2 to 3 bush.	1½ to 2bsh
Oats	Feb. to April	4 to 6	3½ to 4½	2½ to 3
Barley	Feb. to May	3 to 4	2½ to 3½	
Rye	Aug. and Sept.	2½ to 3½	2 to 3	
Beans	Nov. to March	3 to 4	2½ to 3½	2 to 3
Peas	Jan. to March.	3½ to 4½	3 to 4	3
Tares	Aug. to March	2½ to 3	2 to 2½	
Buckwheat	May	2 to 2½	2	
Clover, Red	March and April	12 to 16 lbs.	10 to 14 lbs.	
Clover, White (Mixed seeds.)	Ditto	3 to 4 lbs.		
Trefoil (Mixed seeds.)	Ditto	2 lbs.		
Red Clover (Mixed seeds.)	Ditto	2 lbs.		
Rye Grass (Mixed seeds.)	Ditto	1 peck		
Turnips	May to Aug.	2 to 3 lbs.	1½ to 2 lbs.	
Mangel-wurzel	April and May.			
Potatoes	March to June.	—	—	20 to 25

plants on each square foot of ground; and, indeed, my general experience leads me to be of opinion that they cannot thrive if they are much thicker, for, wherever a greater number of plants spring up, the weaker ones disappear, and only the more vigorous arrive at maturity.

But as, in the ordinary process of sowing, it is impossible to ensure the seeds being uniformly dispersed, and can still less expect every plant to succeed, we cannot be at all guided by these statements, however true they may be; therefore the sowing should always be sufficiently thick to leave no spot scantily supplied with seed, and then either trust to nature to thin the plants on those spots where they may be too thick, or clear it subsequently by hand. As experience has pretty generally determined the measure of seed, which, according to the ordinary manner of sowing, is the most suitable, and as those who have endeavoured to reduce that quantity have generally been far from successful, so long as they persisted in adhering to that reduction, the agriculturist will do well to adhere to the old proportion.

But if the method of sowing can be sufficiently improved to enable us to calculate upon the seed being uniformly dispersed, and if the mode of burying the seed can be so contrived as to ensure each grain being placed exactly at a proper depth, the success of the crop may be thus rendered more certain; and if, at the same time, the richness of the soil leads us to entertain well grounded hopes that each plant will put forth several suckers, it is evident that, at least, half the seed may be saved.

The greater or lesser quantity of seed to be sown should therefore be determined.

1. By the skill of the sower, as upon this depends the uniformity and equality with which the seed will be dispersed over the surface of the soil.

2. By the goodness of the seed, or by its being such as leads us to believe that a very great majority of the grains will produce healthful plants likely to attain maturity.

3. By the temperature being favourable or unfavour-

able to the sowing; and by the state of the moisture of the atmosphere and soil being more or less advantageous to the kind of grain which is to be sown.

4. By the firmness or looseness of the soil, and the state in which it is at the time the seed is sown; and whether such a state is likely to be favourable or not to the process of germination, and the striking out of the roots of the plants.

5. By the fertility and richness of the soil, and its adaptation to the nature of the produce to be sown in it; as this latter point may have considerable influence upon the development and success of the plants.

6. By the period at which the sowing takes place. Early sowings favour the growth of suckers, and this growth then takes place before the plants acquire stalks. This point is of so much importance that, in some kinds of grain, only half as much seed need be used when the sowing takes place in July, as would be required if that operation was performed in October.

By duly weighing all these considerations, a clever agriculturist will be enabled to determine whether to diminish or increase the amount of seed to be put into the ground, without troubling himself with any of those theories which advocate the seed being sown thickly on rich land, and scantily upon poor land, or *vice versâ*.

Among the greater number of those agriculturists who, in tilling their land, blindly follow one old routine, we find a greater inclination to augment than to diminish the quantity of seed. This proceeds partly from a prejudice in favour of the maxim, which inculcates the doing of too much rather than too little; and partly from the fact, that in the early stages of their growth and vegetation, thickly sown plots have always a finer appearance than those which are thinly sown. I have always observed that persons are gratified by the sight of thickly covered fields, although it must have been evident that the greater number of plants must, of necessity, be stifled and perish, in order to leave room for the others to arrive at maturity. In their reciprocal struggle, the plants always weaken each other; and hence a period always arrives, when those thickly covered fields assume a yellowish tint. If the weather be unfavourable, whole patches of vegetation perish, and vacant spots are left where there were previously the greatest number of young plants. I do not deny that the plants which perish afterwards serve as manure to those which remain, but this is a very expensive kind of manure; and it not unfrequently, especially in autumnal sowings, causes a general putrefaction.

The principal motive usually assigned for sowing the seed very thickly is the necessity of stifling weeds; but I cannot say that I ever found it productive of this result. A plant which throws out numerous strong suckers, without, however, forming a compact tissue on the soil, compresses the weeds; but this is not the case with thickly sown plants. If the soil and the temperature are more favourable to the seeds of weeds contained in the soil and mixed with the grain than they are to the kind of grain which has been sown, the weeds shoot up as well as the corn, and often maintain their place better. The excessive thickness of the corn is in itself sufficient to prevent it from vegetating quickly. There is an example of this in the marshes of the Oder, where twice the usual quantity of oats is generally sown, often as much as three bushels (*scheffels*) of seed are allowed per acre, and yet the weeds are there as abundant as in any other place: they always dispute the ground, particularly with corn; and the temperature, according as it favours the one or the other, decides the mastery, unless these weeds are torn up by the hand, an operation which most small farmers undertake. I adhere firmly to my practice of sowing one-half as thickly as my neighbours, and can safely say that I do not suffer more from weeds than they do; nor have I ever yet found myself reduced to the necessity of laying down my arable land as pasturage on account of the weeds having gained the ascendancy. In fact, the ordinary quantity of seed is sufficient to cover the soil so completely that each spot will bear a more than adequate number of plants. The only kind of grain which I sow more thickly than any other is oats upon fallow or newly broken pasture ground, and that because then every grain does not fall on a place where it can germinate.

The processes of sowing vary infinitely, and it is scarcely possible to give a verbal description of them; but this operation, however performed, is always an important one. The best mode of proceeding is, doubtless, that which is termed the *broad-cast sowing*, in which the sower throws the seed, as he goes up the field, to the left with his right hand, and as he returns to the right with his left hand, or else he walks on the edge of the furrow and casts it with the wind each time coming along the edge of that portion of land which was sown by his preceding cast; but this kind of sowing requires very great nicety and some skill on the part of the sower. But the wind must be well observed, and the extent of its power calculated. In all cases that mode of sowing is best in which the sower is most skilled, and there is always some risk in adopting a new one until the man has practised it carefully.

It is a generally acknowledged fact that the sower is one of the most important of all the agricultural labourers; many agriculturists, however, attach little or no importance to the selection of him, and entrust this operation to any day-labourer or servant. They even go so far as to set him, as his day's task, a certain quantity of grain to sow; this the man likes well enough, for it is very easy for him to cast a great quantity of seed into the earth. In most farms an excessive quantity of seed is used compared with the extent of land sown, and it becomes necessary to sow thickly in order to make up for the badness of the sowing. If it be desired to fix upon some sort of rule for guidance, let the quantity of seed be based upon the extent of land to be sown; and, first of all, let a skilful sower be secured, and care taken that he shall not be too much hurried, but kept in a humour to do his work properly.

It has often been asked how much work a sower can do in a day: *De Munchausen* has calculated this in his first volume of "The Father of a Family." But we ought to be satisfied if a sower sows eighteen acres per day. This is undoubtedly the least that a man of ordinary activity ought to get through, and I have met with many skilful sowers who will get through twice as much. But the action of sowing is very fatiguing; and a man who, by the uniform and equal manner in which he disperses the seed, saves a great deal, has some claim upon our consideration. If he be neglectful, he should be immediately discharged: it is in the utmost degree necessary that the skill of the sower should be ascertained, since on that depends the nature and extent of the preparation which must be made for covering the seed.

On very large farms two sowers often walk side by side, and act at once; but these men should be accustomed to act in unison, otherwise harm rather than good will result from the practice. For my own part, I prefer assigning to each sower his own separate space.

Still greater skill and more attention is requisite to sow fine seeds, and spread them uniformly and in small quantities over the ground, than is in the sowing of grain; this operation ought only to be confided to persons who are conversant with it.

The difficulty which has been experienced in certain localities of finding good sowers, has rendered the drill ploughs or sowing machines particularly valuable. Several have been invented and recommended, but I cannot say that I have yet met with any machine of this kind which distributes the grain uniformly. Indeed, I have only seen the models, and have not witnessed the performance of the operation of sowing by one of these machines, or seen the crops sown with it. Some drill-ploughs have been invented which only spread the seed, while there are others which both spread and cover it at the same time. The first of these may be useful, and is very simple; the others are complicated, not to be depended upon, and do not distribute the seed uniformly. I doubt whether any machine whatever can equal the sowing of a good sower; but I am willing to admit that its action may be far preferable to the performance of a bad one.

It is quite otherwise with drills or machines intended for the purpose of sowing in rows, for they deposit the seed at regular distances, and leave intervals of space between, which may either be hoed or stirred. Without them it is almost impossible to sow with any degree of regularity, nor can the plants be dispersed in an uniform manner; but, on the contrary, there will be an accumulation of seed in the furrow — which defects can only be counterbalanced by careful hoeing.

Hereafter, when I have described the manner of sowing different kinds of seed, I will speak of some of the most important points relative to cultivation in rows.

The period at which the seed shoots up and begins to show itself, depends partly upon its particular nature, and partly upon the nature of the soil and the state of the temperature. All plants present themselves either with a leaf, or in the form of an awl, or with two seminal lobes. All gramineous plants rise from the ground in the first-mentioned manner: we will now proceed to treat in general terms of the sowing of that class of plants.

Taking the word in its strictest sense, we mean by the expression *corn*, plants bearing ears and belonging to the gramineous class, and which we cultivate for the sake of the nourishment contained in their seed or grain. It is true that many persons include under this denomination all the various kinds of plants which are cultivated for the purpose of procuring their seed, and employing it as an aliment; but, as those we designate corn are of a higher order, and resemble each other more than they do any other kind of plant, we shall apply this denomination solely to those which belong to the genus of gramineous plants properly so called.

It has not yet been ascertained in what place corn grows spontaneously, or, indeed, whether any countries exist in which such is the case; for nothing exists to prove that it has been anywhere met with growing wild. This circumstance, and the probability that it is very much changed from its primitive state, apply in common to it and to domestic animals, both of which have appeared in all climates where man has been, and have accommodated themselves to all the various changes and modes of human existence.

If we consider them in an economical point of view, they are distinguished from other gramineous plants by their seeds, which are larger than those of other plants, and full of flour, and it is this reason which induces us to cultivate them; the seeds of various other gramineous plants are equally nourishing, and of a similar nature, and are occasionally employed as food, as, for example, tares.

It appears that they were originally annuals in warmer climates. Some of them only have been habituated by cultivation to pass the winter in the earth, because our summer does not suffice to bring them to maturity.

They have, like almost all the gramineous tribe, a disposition to form tufts, and to multiply themselves by throwing off suckers and knots of new roots, which latter again produce new offsets, particularly when new earth has been piled round these shoots, and the growth of the stems stopped. By carefully preventing these latter from growing up, it is possible to preserve them for several years, and oblige them to form a thick turf.

They may be made to produce an enormous quantity of seed by thus encouraging their multiplication, making them throw off suckers, and then separating and replanting their offsets. It is thus that the Irishman, Millar, procured in one year 21,109 ears, and in these ears 576,840 grains of corn, from one grain which he planted in June, and from which, at different times during the following spring, he obtained offsets, which he planted; and he was of opinion that, if he had tried, he might still further have increased this quantity.

Several other persons have, with still less care, obtained frome one single grain 40,000 grains in one year only; so that it is laughable to hear persons talk of the seed being multiplied 80 or 100 times, as if that were something extraordinary.

These gramineous plants always extend innumerable fibres from their roots to the superficies of the soil, and bind it together by the tissue thus formed; they likewise ramify considerably in the depth of the soil, wherever they find loose and rich earth.

All sorts of corn or grain contain constituent parts of a similar nature; but which vary in their proportions, and, in some sorts, in their combinations.

The first of these constituent parts is *gluten*. This substance was first of all discovered in wheat, and attributed to that kind of grain only; but it has since been found, although in a lesser quantity and more closely united with the starch, in other kinds of grain. This substance is intimately allied with animal matter; it is composed of the same primitive substances, and acts in the same manner when undergoing alteration, or submitted to the action of fire. Hence it forms the most essential aliment of the animal frame, and the nutritive properties of wheat depend, where there is an equal weight of flour, on the quantity of this substance which the grain contains. The proportion of it found even in same kinds of grain varies greatly.

The second is *starch*. This substance is probably inferior to gluten in point of nutritive properties. Nevertheless, it is very nourishing, and appears to favour the digestion of gluten. Instinct strongly inclines both men and animals to covet it as food; and, in the long run, it is preferred to gluten, which often tends to cause illness. Cattle fed in starch manufactories afford an excellent illustration of this.

The third is a sweet *mucilaginous* substance, which is only to be found in small quantities in wheat; but which increases during germination, or in the preparation of malt, and is formed of starch. It is by means of this substance that the grain becomes adapted for acetous or vinous fermentation; it appears to be akin to starch in point of nutritive properties, and to assist in the digestion not only of gluten but also of starch itself.

In the natural state of the grain, these three constituent parts are only blended together. By the simple act of digestion, or by the process of making into bread, they become more intimately combined, and can then no longer be separated. In digestion a mass is formed similar to glue; but in the process of making bread, fermentation takes place which produces carbonic acid, and renders this aliment easier of digestion.

The fourth is the *husk*. This is composed essentially of fibrine, which cannot be dissolved by means of digestion alone; however, it contains a somewhat soluble and aromatic matter.

The fifth is *moisture*. This is to be found even in the driest grain; it increases the weight and bulk of the grain, although it diminishes its specific gravity. It yields no nourishment, and is of no advantage; but, on the contrary, when existing in too large a proportion, it accelerates the deterioration of the grain, for which reason grain should always be kept dry. The artificial modes of drying grain, which are practised in the northern countries on the borders of the Baltic, by means of drying floors or planks, tend to preserve the grain much longer, especially if it be placed in large heaps, by which means it absorbs less of the humidity of the atmosphere. Grain which has not been dried in any way ought, on the contrary, to be exposed in thin layers, so that it may be generally exposed to the air; it should be frequently stirred or otherwise moved about, in order that the moisture which it contains, as well as that portion which it attracts from the atmosphere, may evaporate. Different observations and experiments tend to give rise to the belief, that by means of an absolute seclusion from contact with atmospheric air, grain may be prevented from deteriorating; but this cannot be, unless it has first been thoroughly dried*. These constituent parts vary in their proportions not only in the different varieties of grain, but also in the same kind. The temperature of the season, the kind of manure bestowed on the soil, the maturity of the crop, and the period at which the harvest takes place, all conspire to influence the relative proportions of these matters. Corn which has grown on a humid soil, and in a moist temperature, has a very thick husk, and, consequently, is not so heavy as that grown under opposite circumstances, although apparently the same in volume. The proportions of the other constituent parts vary in a like manner. Hence it happens that we often find grain grown in one year so much more nourishing than that of others.

The nutritive properties of grain are not always in exact proportion with its weight; the ratio is, however, very approximative, and much more so than that of the nutritive properties with the volume; consequently, it will always be advisable to buy, estimate, and employ it according to its weight rather than its measure. This is now generally admitted with reference to the manufacture of brandy from grain: skilful and experienced distillers are always guided by weight rather than measure.

The weights of the different kinds of grain vary; a bushel of grain, Berlin measure, will weigh as follows:—

Wheat ....from	84	to 96 lbs.
Rye	76	.. 86
Sprat, or Battledore Barley	65	.. 84
Small Barley	55	.. 70
Siberian Barley	74	.. 86
Oats	42	.. 56

The produce of different kinds of grain depends, where the temperature is equal, on the fruitfulness of the soil; and these kinds of produce exhaust the soil in proportion to the luxuriance of the crop, the size of the grain, and

* On the borders of the Adriatic, and in situations where the influence of the atmosphere and of insects are very prejudicial to grain, I have seen wheat preserved in walled pits formed in the earth, having but one orifice, and that one hermetically sealed. A long stick is inserted into this pit, which reaches to the bottom; and this is from time to time drawn out to show the state of the temperature of the grain in the interior of the pit. If it indicates heat, the grain is immediately taken out to give it air.—French Trans.

the quantity of nutritive matter which it contains. For their vegetation and increase depend in a great measure, if not entirely, on the nutritive matter suitable to it contained in the soil, but the proportion of these required has not yet been determined.

Some persons have endeavoured to determine the sum total of the produce of each kind of grain throughout entire provinces and countries: but the data whence these conclusions were deduced were far too vague to be depended upon, and, consequently, no reliance can be placed on them; much less can they be applied to particular cases, and to certain modes of cultivation. Thus, when we take the average of several years, we find that our calculations are sometimes above and sometimes below the results above named.

In Northern Germany, the average is usually taken from the triennial rotation with a fallow.

Of wheat	7 bushels.
Rye	6
Barley	6
Oats	5

according to the order in which these crops follow the last amelioration.

In countries where a great part of the land is badly cultivated and carelessly sown, this average must be taken at a lower rate; only five bushels per acre must be allowed. *Schwerz*, according to his notes, which however cannot, in my opinion, warrant such a deduction, states that the average in Belgium, per acre, Magdebourg measure—

Is in wheat	11·80 bushels	Berlin measure.
Rye	12·98	"
Autumnal barley	17·95	"
Oats	24·76	"

He contrasts with this several of the statements of Arthur Young, in his travels through the north, south, and east of England, and calculates the general average of the produce in England at that period, viz., from 1760 to 1770, at per acre, Magdebourg measure—

Of wheat	9·39 bushels,	Berlin measure.
Rye	9·58	„
Spring barley	12·60	„
Oats	14·38	„

Hence he infers the agriculture of Belgium to be superior to that of England. Taking this latter as a whole, nobody will deny the truth of his inference, not even the English themselves; but, if he here includes this rotation, which was formerly only practised in some small districts of England, and which has not until lately been generally adopted, or if he means to infer that this rotation is not so good as any other, not only does he draw a false conclusion, but he shows that he has not read Young with attention, and that he has not comprehended the end at which he aimed, which goes directly to prove that the ordinary agricultural undertakings in the provinces through which he has passed are still very imperfect, and that they might and ought to be improved by a better system of tillage. If he had exhibited the average produce of improved farms which Arthur Young gives, particularly in those of his travels, which were made at a later epoch, when there had been several established, the result would have been nearly as follows:—

For wheat	15 bushels	per acre.
Barley	18	„
Oats	24	„

In those provinces they do not cultivate rye, at least to any extent.

I have spoken in the first volume of this work of the proportional value that one kind of grain bears to another.

During the period of the vegetation of cereals, great attention must be paid to those circumstances and accidents which we are about to notice, and to the making of those preparations which we shall point out.

So far as regards autumnal corn, it is considered advantageous for the plants not to shoot much at first; but, on the contrary, for the grain to lay in the earth for a period proportionate to the temperature which they contain, because then the inferior part of their germ, the root, becomes more developed and gains strength. I have remarked, where the weather is favourable and the soil deep, the seeds spring up just three days later than they do in a shallow soil. When an extraordinary state of dryness in the soil causes the seeds to germinate very slowly, we cannot regard this as advantageous; however, it is only injurious on account of its retarding the vegetation too long. In the autumn of 1810, the rye sown towards the end of August remained in the ground until nearly the end of October, that is to say, seven or eight weeks, and many persons thought that it would never spring at all. It did, however, eventually shoot above ground, and came up tolerably thick, and would have yielded a good crop of grain if the drought had been less excessive in the spring, and it had been able to throw off suckers as usual. With respect to spring corn, it is desirable, on the contrary, that it should come of promptly, in order that the weeds may not gain the ascendancy.

It is a good sign when corn comes up in a uniform manner, whether we consider it with relation to time or strength. If it comes up slowly, and be unequal in strength and colour, that announces some disease. It is more deplorable to see spring corn shoot up at twice than autumnal corn, because the latter acquires a uniform appearance more easily in the spring, whereas the other retains the disparity.

The germ which first appears ought to be of a deep colour: if rye, a brown verging on red; if wheat, rather brown; if spring corn, of a deep green; but in no case should it be tinged with yellow: this latter hue denotes a disposition to disease, from which the plants seldom recover. The first leaves which develop themselves should be short, thick, and somewhat obtuse at their points, tough, elastic, and given to curl and contract themselves.

After the development of the first leaves, the stalk forms a knot above the root; this knot opens, and from all sides of it come out lateral shoots. The more perfectly this takes place, the more vigorous may we expect the corn to be. These shoots must not grow too speedily, still less should they fall or fade on account of weakness; on the contrary, it is desirable that they should rise tough and elastic above the soil. In autumnal corn I have frequently seen off-sets shooting up vigorously, acquiring a great height, and bearing leaves of a light green hue, succeed to an amelioration of the soil in which manure had been buried a short time before the sowing, during moist, warm weather: this activity of vegetation was attended with the most deplorable results, and all that remained in the spring was a field almost entirely despoiled of vegetation. It appears that in such a case the amount of hydrogen contained in the plants was out of all proportion to the carbon which they contained. Under such circumstances as these, it does not appear to me that there can ever be any disadvantage in the soil being richly furnished with plants, even though the leaves were to rot the plant; for the plant, protected by its lateral off-sets, would remain healthful, and in the spring would résume its vegetation.

The commencement of winter finds autumnal sowings in various conditions: some of the kinds of grain have not germinated, when others have begun to shoot. In whatever state they may be, I have never yet seen them destroyed by frost. During the extreme cold weather of the rigorous winter of 1802 and 1803 the earth was free from snow, yet I could not perceive that any plant had been destroyed; I had not, however, any opportunity of seeing white wheat. In the following spring all the sowings looked wretchedly; those which had thrown off suckers before the commencement of winter had lost their leaves, which at first turned of a whitish hue, then half rotted, and at length dropped upon the soil: no new shoots were perceptible. It was not until the end of April that the rye began to put forth new shoots; the wheat did not recover itself until the end of May. Up to that time the frost, which had penetrated the soil to the depth of more than three feet, absorbed the whole of the caloric brought into contact with the soil by the atmosphere. Subsequently the plants shot up again with promptness and vigour: no blanks were to be perceived, excepting in those places where the soil had cracked to such an extent as to render it dangerous to approach it; and even these places were subsequently covered to a tolerable extent after being closed up by the expansion of the earth. The rye alone, which had been sown on shelving beds of sand, wherein it had thrown off no suckers before the commencement of winter, was found to be destroyed; a strong easterly wind having swept away the sand, and left the roots bare.

The seed is, undoubtedly, best preserved under a bed of snow, particularly when the superficies of the soil is somewhat hardened before the snow falls. It continues to grow beneath this covering, and the seed which has been buried for but a short time shoots out and springs up beneath the shelter of the snow. However cold the weather may be, and however long it may last, the seed thus covered does not suffer at all from it; indeed, the coldest winters have always been followed by the most abundant harvests of autumnal corn. Mild winters, with frequent alternations of heat and cold, are invariably injurious to all seeds sown in a moist soil, unless good and sufficient measures are taken to keep the soil well drained. Neither should the snow be trodden or pressed down upon the seeds; wherever footpaths, or even footprints, have been made in deep snow, the greater part of the plants underneath disappear.

When the snow and frost are disappearing is a very dangerous period, if not the most dangerous of all. The seed is liable to be drowned if the snow happens to be precipitately melted by rain, and the water be so enclosed that it cannot flow off, or the ditches so full of frozen snow that it is impossible to open their channels. In such cases nothing but extreme promptitude and activity on the part of the farmer can save the seed; he must employ all the hands he can muster in endeavouring to procure a drainage, and, after all, he will sometimes strive in vain, it being impossible. On a soil through which the water filters freely, some hope may be entertained that it will sink into the earth before the plants perish; but such can never be the case when the frost has taken deep hold of the soil. A thaw is still more injurious to the seed when it comes on very slowly, and is accompanied by alternations of frost. When there is sunshine during the day and frost during the night, or, what is still worse, when there happens a fall of snow during the night, which is soon melted by the sun, the thawed superficies of the soil becomes saturated with water, which is unable to penetrate through the inferior stratum, and still continues to be hardened by the frost; this water freezes during the night, and, in doing so, raises up the superficial layer of earth subjected to its influence, and with it the plants growing there. During the day the earth thaws again, and the earth falls back to its original position; but the plants, being lighter, remain on the surface, wholly denuded of earth. For several successive nights and days the same thing is frequently repeated, and by far the greater number of the plants are thus uprooted, even the roots themselves being broken where their lower extremities have been tightly fixed in the frost-bound earth. Even the most vigorous plants cannot entirely resist such weather; those, however, which have most roots and are most tufted, bear it better than others. The more porous the soil, the greater is the danger.

Such weather as that of which we have just spoken occurred in March, 1804; and it was the sole cause of the partial failure of the corn crops, and the dearth of grain which was felt that year, which was, nevertheless, otherwise favourable to vegetation.

In the spring, if the seeds do not come up well, or the plants appear to be rather thin, people are apt to become alarmed lest they should have been entirely destroyed during the winter, or else have suffered too much to admit of the hope that they will yield even a passable harvest, and often hastily determine on ploughing the land up. There is no year that I can remember in which the farmers were so uneasy, and so much in doubt as to what they should do, as in 1803. However, the greater number of those who ploughed up their autumnal corn in order to sow spring barley regretted it afterwards; because the autumnal sowings which were allowed to remain yielded a far better crop than the barley by which the ploughed up portions were replaced. Indeed, a satisfactory crop of barley is rarely obtained under such circumstances; oats will, in general, be found to answer better.

Sometimes agriculturists have carefully harrowed autumnal wheat which appeared to be quite destroyed, and then sown oats on the ground; they have subsequently reaped oats and wheat together, and, upon the whole, had a good harvest, but the wheat has exceeded the oats in quantity.

The experiments made on this point by some of the Mecklenburg agriculturists, and which are narrated in the second part of the "Annals of the Agricultural Society of Mecklenburg," are both interesting and remarkable.*

It has also been found, that by passing a harrow carefully over the ground in spring, when the soil is thoroughly dry, very beneficial effects have often been produced, even when the labourers have expressed their fears that the operation would absolutely destroy all that remained of the wheat plants. Harrowing is, without doubt, one of the most beneficial operations which can be applied to autumnal corn; but it must be sufficiently effective to cover the whole field with a layer of loose earth, as will always be the case when harrows, having iron teeth, are made use of. Recourse may be had to this operation with advantage in every case, excepting, as we have already

* See the "Annalen des Ackerbaues,"

said, where the plants have been uprooted, when it will be better to roll the ground. A mild dry March is particularly favourable to the vegetation of autumnal corn, as well as to the preparations for putting in spring corn.

In the spring, all corn which looks well and healthy ought to put forth lateral shoots, extend itself over the soil, and gain strength, rather than run up rapidly. The vigorous nature of a plant which has already begun to show off-sets in the autumn, contributes greatly to further this end; but the weather must be favourable, the heat in April and the beginning of May very moderate, and a sufficient quantity of rain must have fallen to moisten the ground and render it favourable to the vegetation of thickly tufted corn. Then the operation of harrowing will prove particularly beneficial, especially if performed in a proper manner and at a fitting period, the layer of newly loosened earth encouraging the plants to sprout and put forth new shoots. Should they, however, after this shoot up rapidly, with only one or two stems, and run to stalk, as very frequently happens when there is a sudden rise of temperature unaccompanied by rain, the corn never becomes thick; and even though lateral shoots subsequently appear, which are called "May-shoots," they being so much later than the principal stems, never produce any ears of much value. It is not so much the crowding together of the plants, as this multiplication and elongation of the off-sets, this uniform sprouting of new stems, which decides the question as to the richness of the harvest, and in that the appearances change almost incessantly. One field, which at the commencement of May is covered with plants, and makes a very great show, will in June be but scantily furnished with ears, the plants having run up to a great height and become stalky; whilst another, which appeared to be very much behind-hand in May, will in June present the aspect of a field of thickly tufted corn, luxuriantly furnished with ears and thick stems. Most agriculturists will have had opportunities of observing this phenomenon, but only a very few of them have profited by this experience; since they mostly like to see their fields covered with straight thick plants in the autumn and early in the spring, without caring to consider whether these crops bear any indications of strength or are likely to shoot out luxuriantly. The aspect presented by a field of corn, cursorily examined, is very deceitful. It is only by going over the field and examining all the plants separately, that any definite opinion can be formed with respect to its fruitfulness.

The slower the growth of the stems and the development of the ears, the better. A forward, precocious crop, will never be a luxuriant and plentiful one. The ears should be uniformly developed over the whole field about the same time; and for this reason, cool, damp weather in May is considered to be favourable to the production of a plenteous harvest. At the time when the ear begins to form, the plant will have attained the half of its ultimate height; at least, I have always found this to be the case as regards rye. The strength of the stems, particularly towards the bottom, is of quite as much importance as their height. It is only when the stems are proportionately strong that the length of the ears will be in proportion to that of the straw; as, for instance, the ear will be nearly as many inches long as the entire stem is feet in height. Thin, wiry stems often attain to a considerable height, and, nevertheless, bear small ears. The knots of the stem ought to be thick and brown; the blades of a deep rich green, and stiff. When the ears have acquired an increase of growth, and the flowering begins, the corn ought to present a uniform surface, and all the plants be the same height. When some ears here and there shoot up higher than any of the others, it does not presage a good harvest.

The flowering season is also a critical period for corn. If the temperature continue to be wet for any length of time, fecundation will be difficult and imperfect. In June, a dry and warm temperature, with a few intervening showers, is desirable. As the weather exercises a considerable influence, especially on rye, I shall take occasion to revert to this subject again. It is astonishing how much greater a resistance vigorous corn opposes to the action of weather, &c., than that which is offered by the weaker kinds.

During and after the period of flowering, comes the danger of the plants being laid. When corn is laid previously to this, without being beaten down by heavy showers or hail, it is in consequence of the excessive richness of the soil, a circumstance which every sensible and prudent agriculturist should always take care to avoid. Corn which has been beaten down previously to the flowering period, soon rises again, but not without retaining a slight curvature.

When the corn is laid by rain, this evil is so much the greater in proportion as it takes place at an early period. It is not always the crowded condition of the stems, or their multiplicity, which causes the corn to be laid, but usually the weakness of the plants and their disposition to disease; for we often see corn that is very thin and scanty, in one field, laid; while that in an adjoining field, although thick and luxuriant, will remain erect. Very abundant manuring, with superficial and badly executed ploughing, accompanied by very thick sowing, constitute the ordinary causes of the laying of corn; whilst deep ploughing, performed with care, and seeds well furnished with offshoots, rather than thickly sown in the first instance, prevent this inconvenience. In the latter case, the stem has more strength at the lower part; and in the former it rises too rapidly, and obtains height, and perhaps strength of blade, at the expense of the stem. All corn which is of a yellow colour indicates the presence of too much hydrogen in proportion to the carbon, and consequent weakness.

What I have just said has reference principally to autumnal corn; however, in most points it may be applied to spring crops as well. The peculiarities of each will be noticed when we come to treat of the several species separately.

Amongst the different diseases which, under various forms, attack corn as well as other plants during the period of their vegetation, the following are the most common and remarkable :—

Abortion; or, the shedding or falling of the grain. This disease causes the plants to become suddenly white or yellow, as if at the period of their maturity, and are soon completely dried up.

It is partly the top of the plant or the top of the ear that is first diseased; and this appears sometimes to be occasioned by the return of cold, or white frost. Grounds exposed to the north wind, and the highest parts of fields are most subject to this disease; but it is often seen in wet land, and still more often in fields surrounded by woods, where frosty vapours fall in great abundance, which have a fatal influence on the young ears by suddenly chilling them.

Upon dry soils which contain great heat, and where the want of rain is experienced, we see another disease of a similar kind, but which attacks the whole plant: this disease is not confined to sandy soils, but manifests itself in fields which have been only superficially ploughed, which are never left in repose, and which are abundantly manured with new manure a short time before the seed is put into the ground. I know extensive arable lands on which this disease always attacks the rye during dry weather, and the owners of the land believe it to be inevitable. Allowing the land to remain fallow, laying it down to pasture, ploughing it deeply, or spreading the manure over the surface after the seed is got into the ground, will be sure to eradicate the evil.*

A disease called by the English, *blight,* and which is of a totally different character to the one of which we have now been speaking, is seldom met with among us; it only manifests itself now and then, and usually appears in wet localities. It consists in a sudden paralysis of the vital strength, a mortal apoplexy, a sudden death which attacks the plant. I observed this disease to be

* *Vide* "Wilrich uber das Verscheinen der Saaten." Niedersachs: Annalen. Jahr. iv. st. iii. 54. A.

prevalent during the rainy but warm summer of 1802; it showed itself in patches in moist situations: one day an extent of some feet would lose colour, on the next this appearance would have extended over the crop to a distance of thirty or forty perches. The plants became completely white, and as dry as straw. It was easy to pull them up, and all their principal roots came up with them quite white and dry: nothing remained in the soil but a few fibres. During that summer the disease of which we are now speaking was far more prevalent on the fields in my neighbourhood than upon my own; some persons attributed it to the ravages of an insect; but I was never able to discover a foundation for such an opinion, nor could I discover that the plants had received any injury which could account for their rapid decay. This evil appeared to me to be attributable to an electrical state of the air, or to an instantaneous mutation of positive and negative electricity between the currents of air and the earth, which were signalized by various indications, though no storm manifested itself in the neighbourhood. It has long been considered that lightning has a baneful effect upon every kind of cereals, particularly if it comes about the time of flowering.

Mil, or mel-dew brand, and smut, appear to me to be analogous the one to the other, or, at least, to have one common origin. Some agriculturists comprise under the term brand, both the mildew and smut; and, in fact, the latter appears to me always to be a consequence of the former. The *mil*, or *mel-dew*, or, as it is vulgarly called, the *honey-dew*, is a glutinous sweet humidity which exudes from the plants, and is similar to honey: it is very agreeable to bees. Nobody will believe in our days that it falls from heaven, since it often attacks one whole crop of corn, while that which is perhaps in the very next field is free from it; the primary cause of it doubtless lies in the atmosphere; the disease is most prevalent when, in the middle of summer, and while the plants are in full vigour, during or after the flowering season, sudden changes take place in the air, and heat is succeeded by instantaneous cold: in fact, it is a disease produced by chills. Upon some vegetables, as French beans, there are immediately seen a quantity of animalculæ, which are undoubtedly the consequence, and not the cause of the disease. Among cereals, a small red insect may occasionally, but not often, be remarked: throughout the whole of the plant signs of weakness are observable, and its vegetation is checked. Should a more favourable temperature, however, supervene, accompanied by gentle showers, the plants will often be restored; yellow spots will continue to be visible upon the leaves and stem, which gradually acquire a deeper hue, and at length burst, shedding a brown powder; this is what is properly called *smut*, and I have almost invariably seen it succeeding to *mildew*. Botanists have for a long time considered these balls or spots to be little fungi, which grow on the leaves; and Sir Joseph Banks, the President of the Royal Society of England, in a recent description of this disease, which made such terrible ravages in England, particularly in 1804, has given a very magnified and detailed drawing of it, in which the form of the fungus is very clearly to be traced. Many botanists consider it to be a parasitical plant appertaining to the class cereals, and term it *æcidum*. For my own part I am much more inclined to regard it as a disease of the skin; for plants as well as animals are subject to such; and each has a certain form. If this disease once gets a head, the plant soon becomes so weak that it is incapable of bearing grain, and all hopes of a fine and plentiful crop vanish. This disease is more frequent in some climates and countries than in others; and it is peculiar to those which are much subject to fogs. One very extraordinary fact is, that the barberry bush will produce smut, or something very similar to it, in all corn growing within a considerable distance of it. This is a fact which has been confirmed by numerous observations and experiments in almost all countries. But it has never yet been clearly and satisfactorily ascertained in what manner the barberry produces this effect. My friend Einhoff has made several experiments on the possibility of communicating *æcidum* to cereals by cutting branches from the barberry which were quite covered with it, and shaking them over the corn, or else planting them in the midst of it; but he never succeeded in thus producing the disease: therefore it would seem that it is not the communication of this dust, but the vegetation of the barberry in the vicinity of the corn field, which engenders the disease. Nor will it attack crops planted near young and newly made barberry hedges: but as these latter grow up the disease will appear, and increase in virulence from year to year, until these hedges are rooted up. As soon as the barberry has been thoroughly extirpated, the evil disappears.

The *farinaceous smut* is a disease in which the plants are covered with a white powdery-looking substance. It seldom attacks cereals, but is usually found among vegetables. It appears to arise from the same cause as honey-dew, with which it is frequently confounded. It attacks those vegetables which are liable to it, about the period of their attaining to maturity; and it is this age, and not the influence of the season, which predisposes the plants to it.

No definite information has yet been obtained with regard to the nature of the diseases of plants. Agriculturists seldom have the capacity or the leisure to admit of their observing and tracing out all the phenomena attendant on them; and botanists and other scientific men rarely have the necessary opportunities of pursuing this study. One opinion after another is brought forward, each founded on different views, and expressed in different terms, and hence endless confusion arises. As I have no intention of venturing upon such dangerous and untenable ground, I shall abstain from entering upon the subject of the analogy which is supposed to exist between the diseases of plants and those of animals. I shall also pass over in silence the various insects which occasionally do so much mischief to corn and other crops.

THE HARVEST.

The getting in of corn and other kinds of cereals is in general one of the most important of all the agricultural operations. We shall at once proceed to speak of the principal circumstances relating to it, without entering into those minor details with which the reader is most probably acquainted; or, if he should not be, which cannot be taught by verbal explanation. The principal conditions requisite to ensure the success of the harvest are, that it shall be got in as quickly as possible; that the plants shall not be allowed to shed their grain; and that the ears shall be firm, dry, and fully matured.

In order to avoid all impediments to the progress of the harvest when once it is commenced, the farmer should make every preparation beforehand; he should air and repair all his barns; see that his waggons, implements, and everything which can by possibility be required are fit for use. Everything, in fact, should be got into a state of readiness, so that not a moment shall be lost after the operation is once commenced; all other operations which will not positively suffer from delay should be postponed. The straw bands, or twists of reeds or osier, with which the sheaves are to be tied up, should also be prepared beforehand, for no prudent farmer will suffer his sheaves to be fastened up with their own straw.

In extensive agricultural undertakings which have but few or no statute labourers, the first care should be to procure a sufficient number of hands; a calculation should be made as to the number which will be requisite, and every possible means resorted to in order to secure them. The usual mode of proceeding is to let off land to labourers, on which they are permitted to cultivate certain things—as, for example, potatoes, linseed, tobacco, &c.—on condition of their helping to get in the harvest at certain wages, or, if they fail to do so, forfeiting the produce of the land which they have cultivated. This mode of proceeding is in general very expensive, but it is often the only means of attaining the desired end.

There are various data laid down for determining the number of labourers which will be requisite to get in the harvest from a given extent of ground, but most of them have only relation to certain localities. By some it has been supposed that six men and eight women are required for three hundred acres of land, two-fifths of which are sown with autumnal and three-fifths with spring corn. In this calculation one man has been supposed capable of cutting three acres per day of fine corn, and from three to five women of raking and binding the corn. The quantity of corn which a team can draw in the course of the day will depend upon the weight of the crop, and the distance of the field from the stack-yard. One man and one woman will be sufficient to load and rake up after a waggon, and three men and three women will suffice to unload the waggon and stack the corn. This calculation is, however, liable to modifications; some labourers being more active than others, some more skilful. The number of persons required will also be greatly influenced by the state of the weather, which often tends materially to prolong or retard the operation.

There are various modes of performing the operation of getting in the harvest; it is, however, very difficult to change from one to another where the labourers cannot be hired from other places, and the farmer is forced to manage with those belonging to the immediate neighbourhood. It is by no means immaterial in which mode the harvest is got in; some being advantageous in one point of view, and some in another. But the various isolated departments, viz., mowing, reaping, raking, binding, loading, unloading and stacking, are all so intimately connected with each other that no change can be made in one which does not pervade the whole series. Any projected alteration must never be adopted without due consideration, since the labourers frequently go very clumsily to work about it, even though it may be much easier than the mode of proceeding to which they have been accustomed; innovations, too, often damp if not destroy that alacrity and cheerfulness on the part of the men which cannot be too diligently fostered during harvest time. Most reapers keep themselves and each other in good humour by intermingling jokes and pleasantry with the progress of their work; but these vanish before the imposition of a new mode of proceeding, and give place to sullenness and discontent; although the probability is that in those places where it is customary, this very mode of operating may be even more merrily performed than that which these men are habituated to. If, notwithstanding this disadvantage, it should still be deemed expedient to introduce some new plans, care must be taken that all the chief labourers shall thoroughly understand it, and that the overseer, especially, shall be intimately acquainted with all its details, and fully capable of giving both directions and instructions with regard to it.

We shall not attempt to describe all the various modes of getting in the harvest, because it is difficult to give a sufficiently lucid description of these proceedings to be of any utility, although they may easily be acquired by observation and practice, but content ourselves with making mention of the principal ones.

The instruments employed in cutting are the sickle and the scythe. When the former is used, the corn is said to be reaped; and when the latter, it is said to be mown. The sickle or reap-hook is to be preferred, when the reapers use it properly, as the ears are then less liable to shed their grain. The chief cause of the preference given to the scythe, is the saving of manual labour which it produces, and the dispatch with which the operation progresses when this instrument is used. No doubt can be entertained but that, when the crops are thick, half laid, and interlaced with each other, the sickle should be used; and the advantage arising from the grain not being shed, will amply cover the extra expense attendant on reaping. But where any of the kinds of grain are allowed to stand too long, merely from a predilection for the use of the sickle, this advantage is entirely lost, and the quantity of grain which is shed and lost during the getting in of the harvest is often much greater than would have been wasted had the crop been properly mowed. It must not be forgotten that when grain is reaped, a very high stubble is left standing, and consequently the amount of straw is decreased. This, however, can hardly be termed a loss on strong, heavy land, where an abundance of straw can always be obtained, and where this long stubble will, if buried by ploughing, tend to loosen and ameliorate the soil.

There are two ways of mowing corn: firstly, by means of a scythe surmounted by a *cradle*, which is made to cut from right to left, and which lays down the corn in swathes on the left; and secondly, by means of a common scythe, in which case the mower cuts towards the standing corn, on which the cut corn consequently rests. This man must be followed by an assistant, whose business it is to gather up the mown corn, and lay it on bands ready to be tied up. This second mode of proceeding can only be resorted to where the corn is strong and heavy. One great advantage attendant upon it is, that it shakes the ears much less, and saves the trouble of raking; corn thus cut is less liable to shed its grain. The labour attendant on it is scarcely greater than would attach to other modes of proceeding, for the women who follow the reaper and gather up the corn save the extra labour of raking.

Many attempts have been made, and not entirely without success, to invent instruments for the purpose of performing the various operations appertaining to the getting in of corn; but the labour was so little diminished by any of them, and the corn in general so much injured, that no advantage whatever can be derived from their use.

The crops are sometimes tied up directly they are mown, while, at others, they are left in swaths or heaps on the ground to dry. The former mode of proceeding can only be resorted to when there is but little grass intermingled with the crop. Some farmers prefer leaving the grain in heaps on the ground until a little rain has fallen. When such is the intention, the sheaves must be made very small, or else they will take too long drying; the best way is to put the corn into sheaves standing, as it suffers much less from moisture while in that position than it does when lying on the ground. Under those circumstances, where the crops must necessarily remain for a considerable time in the field, as will often be the case where a tithe or duty has to be paid on it, the sheaves are placed together in shocks, and a cap or covering, consisting of a head sheaf, spread out for the purpose, which prevents the shock from suffering even from continuous rain. When the corn is made into large sheaves, they should be removed from the field as soon as tied up, and on no account suffered to remain another night exposed to the weather.

Nothing can be so disadvantageous to the farmer as for the weather to be moist and damp at the harvest time, as this state of temperature gives the grain a tendency to germinate. Under such circumstances, he will have need of all his forethought and activity, and must spare neither care nor expense if he would save his crop. He must, above all, preserve his good humour and cheerfulness, for any diminution of either will paralyze all, and cause the labourers, who otherwise take a lively interest in the operation, to become disheartened and sullen. Various modes of proceeding have been recommended for the purpose of preserving corn during harvest from the effects of warm, moist weather; but most of them are only applicable to some few localities.

When the corn is left in heaps or swaths on the ground, they must be frequently opened and turned, in order that the ears may not become attached to the ground, but may be exposed to the action of a free current of air. Whenever there is the slightest chance of the corn drying, it should be immediately tied up, and carted with the least possible delay.

Sometimes it will be found necessary to turn the crop repeatedly after it has been brought into the barns, and to expose it to the action of the air by spreading it over the floor. The corn can only be tied up as fast as it is mown, in the middle of the day, and even then it will be best to set the sheaves in shocks, and cover the top with a head sheaf, or sheaf laid upon its side, and so arranged as to protect the shock from rain; corn may thus be suffered to remain on the field until the weather improves, without any danger of its germinating. Some farmers pile the corn in heaps without tying it, and then cover each heap with a sheaf drawn loosely together at the top, and stretched out at the bottom so as to form a cap. When, on account of the unskilfulness of the labourers, it is impossible to cover the heap properly, the sheaves must be made very small, each one weighing not more than eight or ten pounds, and these must be set up leaning against each other, so that the wind may blow through them. When thus exposed to the air, the corn can bear continuous rains for a considerable length of time.*

With us, the corn is usually preserved in barns until wanted to be threshed; and it is only made into stacks when the barns are too full to hold more. There is a very great difference between our stacks, which frequently occasion so much loss to the farmer, and the carefully, systematically built corn-stacks of the English agriculturist, such as I have described in vol. ii. part 1, of my "English Agriculture." These latter are fully capable of preserving all kinds of corn, without its being in the slightest degree injured or deteriorated; it would, however, be difficult to introduce them into our system, and, in fact, it could not be done unless the sheaves were made very small. A building has been suggested which partakes of the nature both of a barn and a stack, and this is, in my opinion, very likely to answer. There are various opinions respecting the form in which barns or

* Some remarks on this subject will be found in the "Annalen des Ackerbaues," bd. iv. sec. 82; and "Anzeigen der Leipsicher Œconomischen Societæt." Michaelis Messe. 1785. Sec. 50. "Untrügliche Weise bei regnigter Witterung, die Feldfrüchte in Sicherheit zu bringen." Weimar, 1810.

granaries should be built, and also with respect to the superiority of different barn floors. When these latter are long, a whole line of waggons may be introduced at once; but where they are square, not more than three at most can enter. In my opinion, the old custom, whatever that may be, should be adhered to; the advantage attendant upon either of these forms is not so great as to make it worth while to change the mode of getting in the harvest, and alter the construction of the barns. Long floors are chiefly found in those localities where the corn is not laid up compactly until the whole of it is tied; while square ones are principally found where the crop is carted and carried home as soon as any portion of it is made up into sheaves.

When corn is stowed up in barns or in stacks, it is of the utmost importance that no hollows or vacant spaces should be left, but that the whole mass should be compactly pressed together. This point should be particularly attended to, not only because much room is thus saved, but also because the grain then keeps much better. No practice can be more erroneous than that of leaving openings and vacuities with the view of admitting a free current of air, and thereby carrying off the vapours engendered among the cereals; it will always be found that corn keeps best when most compactly stored, and that wherever hollows or spaces are left, mildew will always be engendered.

There are various modes of threshing corn. I shall merely mention those which are effected by the feet of horses, by waggons having ten or twelve angular wheels, and by sledges, or conical rollars*. The usual way of threshing corn is with flails. These implements are not however always similar, nor are they always used in the same way; but none of the modifications, either in their make or in the manner of using them, are of sufficient importance to render it worth while to take the trouble

* A complete description of all these methods, which are now obsolete among us, will be found in "Krunitz Encyclopedia," bd. ix., illustrated by several plates.

of endeavouring to teach the labourers to perform the operation in any way to which they are unaccustomed, especially when they are upon task work.

Threshing is generally executed in one of three ways:

(*a*). In small farms; by the farm servants, either early in the morning or late in the evening.

(*b*). By day work; in this case the number of sheaves which are to be threshed in each day is usually determined beforehand. Where this system is pursued, the labourers must be well looked after, or they will leave the corn in the ear, and otherwise slight the work, in order to save themselves trouble.

(*c*). By task work; here each man has to thresh a certain number of sheaves, or produce a certain quantity of grain. This mode of proceeding is usually practised in large farms where a number of labourers are constantly kept.

The farmer himself, or his steward, or bailiff ought to pay particular attention to the performance of this operation, or the labourers will leave the corn in the ear, cheat, and thieve; besides, these persons must maintain order, look after the threshed portions, and see that the grain is properly freed from all impurities, measured, and carried to the granary.

Various machines have been invented for the purpose of threshing corn, and many of them answer very well.

The best and most generally used threshing machine is one that was invented in Scotland, and which has since been greatly improved and modified. This machine beats the grain and chaff from the straw by means of a revolving cylinder furnished with flails or beaters; it separates the grain from the chaff, dust, and straw, and also separates the light from the heavy grains. This instrument has been made of various sizes; some are put in action by water, others by wind, and others again by two, four, or six horses. Their mechanism is complicated but durable, and, consequently, they are very expensive. There is, however, a manufactory at Friederichswerk, in Seelande, where they may be obtained at very moderate prices: the large and complicated machines which require six horses to put them in motion may be had for 500 rix-dollars; and the smaller ones, such as are usually worked by two horses, for 180 rix-dollars. These machines thresh the corn very evenly, and in proportion to their size very quickly. The only thing which can be complained of is, that they break the straw; but this need not be rendered a ground of complaint, for it serves to make it better adapted for fodder and for litter, without unfitting it for other purposes. In those farms where threshing is an operation which should always be reserved for the purpose of keeping the men employed during the winter, threshing machines can only be of partial use; their advantage and utility is most evident at those periods when it becomes necessary to expedite the work.

With us the grain is usually stored up in granaries, most of which are over some part of the farm buildings, or what is still better, over open sheds. In very large agricultural undertakings, there are buildings set aside expressly for this purpose.

The large massive buildings erected in Russia and Sweden for the purpose of storing up grain, are the best adapted for this purpose; in these the reservoirs are built in the form of tall chimneys, extending from the summit of the building to the ground; when completely filled, they are closed at the top so completely as to prevent all communication with the atmosphere; they are emptied at once by opening an orifice near the ground. The grain must have been perfectly dried in the air, or else in an oven or close stove, before being stored up in these places*.

In Ukraine the grain is still frequently stored up in pits and trenches, as used formerly to be the custom in Germany†.

After having been threshed, the grain should be spread

* "Norberg's Beschreibung eines Kornmagazins in den neuer Abhandlunger der Schwedischer Academie der Wissenschaften," Bd. X. A.

† "Schrebers Sammlung von Schriften zum Kameral Wissenschaft," Bd. X. A.

out to dry on the floor of the granary; at first it should be laid in thin layers of about six inches deep, but afterwards, when it has become tolerably dry, it may be collected more together, and left in heaps or layers of a foot or a foot and a-half in thickness.

The time which has elapsed since the corn was got in, as well as the state of the atmosphere both then and subsequently, will guide the farmer in his after treatment of the grain. Where it has only been got in a short time, and where the weather is damp, it must be frequently turned and moved: at first it ought to be attended to twice a week; afterwards only once a week; and in the summer, when its tolerably dry, once a month will be quite sufficient.

A careful surveillance must be maintained in the granaries to prevent the mischief which is frequently done to grain by insects and vermin. No foreign grain should be admitted into the granary, unless it is ascertained to be perfectly sound, and free from insects. The walls of the granary must be kept in perfect repair; they may be painted, provided that a brisk current of air can be kept up through the place to carry off the smell. When insects first appear, a strong current of air will frequently entirely get rid of them; but if they once get a-head, all that remains to be done is to sell the grain at the best price which it will fetch, and have the granary thoroughly cleansed and purified before any more is placed in it. Various substances may be strewed about it which are injurious and poisonous to the insects, as tobacco leaves, or a wash composed of a decoction of the leaves of the alder or walnut tree; turpentine, pitch, or tar may be inserted into all the clefts or crannies. But the most efficacious mode of proceeding is to burn sulphur in the granary several different times, and thus fumigate the place; if proper precautions are taken, this may be done without any danger of the building taking fire; every opening must be carefully closed up, or the smoke will escape and do no good.

Rats, mice, and weevils injure the grain very much, besides dirtying it with their excrements. Cats, owls, and hedgehogs will sometimes diminish the number of these vermin; but they also dirty the grain. The use of poison for the purpose of their destruction is justly regarded as dangerous; but there is a way in which recourse may be had to it without risk. The first thing to be done is to find some bait which these vermin are fond of, and place it in some spot close by the granary. When it is observed that they eat it with avidity, and devour all that is placed there at night before the next morning, some ratsbane or arsenic should be mixed with it; and thus all the rats will be destroyed in one night. This practice is not attended with the same danger as the dispersion of poison about the granary would be; for the animals who have eaten of the poisoned food set apart for them, do not return to the grain; they either crouch in a corner, or else run up on to the roof, where they soon die. All the grain should then be raked, in order to see if any animal has dirtied it. If any of the poisoned food be left, it must be immediately removed; for should any rat be left alive, he will not touch it.

We shall now proceed to speak of the several species of grain; and, first, of corn, properly speaking.

WHEAT.

From the botanical genus *triticum*, arise four distinct genera which we consider as wheat, and cultivate in our fields. viz.:—

Triticum hybernum et æstivum	Winter or lammas wheat.
„ *Spelta*	Spelt wheat.
„ *Monococum*	One-grained wheat.
„ *Polonicum*	Polish wheat.

The innumerable minor varieties derived from the first species, or wheat properly so called, are but degenerations or varieties which have undergone changes arising

from extraneous circumstances. This opinion is contrary to the one usually entertained, even by botanists, who do not, however, agree with regard to the distribution of the species and varieties of the plants which we cultivate in our fields, and which are under the influence of art. They do not even agree about autumnal and spring corn. Although these two kinds, and especially some varieties of them, appear to differ so widely in their nature, they may, without difficulty, be rendered similar, if not wholly the same. If real autumnal wheat is sown in February, or about the beginning of March, a portion of its lateral offsets produce stems and ears which come to perfection the same year, though they yield but a scanty crop. If the grain thus obtained be sown on the following spring, it will approach nearer to the nature of spring wheat, produce more stems and ears, and ripen quicker; and if the grain arising from this second crop be again sown on the third spring, actual spring wheat will come up. On the other hand, if real spring wheat be sown towards the end of October, and a hard winter follows, in which the plants are not sufficiently covered with snow, the whole of the crop will inevitably perish; but if the temperature is favourable, it will succeed tolerably well, put forth ears, and ripen before the autumnal wheat. The grain obtained from it will, if set, produce plants that bear the winter better, and approach nearer to the nature of autumnal wheat, remain longer in the ground, and shoot up taller and stronger; on the following year it will have acquired all the characteristics of autumnal wheat, remain still longer in the ground, and shoot up still higher and stronger.

I cannot consider the *triticum compositum* (Egyptian wheat) as a distinct variety, since it loses all its numerous shoots, and its distinguishing characteristic, on being sown on poor land, as these arise solely from a superabundance of succulency. After this wheat has been reproduced several times on poor land, it ceases to bear the slightest trace of that multiplicity of ears by which

it is distinguished. The grain, however, becomes larger as the number of the shoots decrease.

That which is termed *triticum turgidum* (turgid, or English wheat), is, perhaps, a distinct variety. The ears and the husk are peculiar, from their structure; the grain, from being wider at the back than any other, and from the absence of that velvety appearance at the round end which is observable in the grain of other wheat. This last-mentioned peculiarity was observed by Crome. Sometimes it is bearded; at others, not. I do not know whether the English distinguish it particularly from other kinds; there is so much confusion among their innumerable varieties. It certainly cannot be considered as one of the most common or generally cultivated varieties among them; the term English wheat, which we have bestowed upon it, is therefore inappropriate.

We shall hereafter speak of the different kinds of Spelt and Polish wheat.

The varieties of wheat are innumerable, especially in countries where very great attention is paid to the cultivation of grain, as is the case in England. I have reckoned more than a hundred kinds of wheat which are recognised by the English, and each of which has a different name; but all these are very frequently confounded, the one with the other.

Haller justly observes, that "the beard is a very uncertain characteristic, since in some soils wheat acquires a beard, while in others it loses it." The English, however, pay no attention to this circumstance.

The colour of the grain is a much more definite sign. Red and brown, yellow and white wheat are always distinguishable from one another. The colour of the straw, when it has attained maturity, does not always agree exactly with that of the grain. For instance, dark coloured grain may frequently be seen growing on white straw, and *vice versa*.

Brown wheat grows in countries where there is strong wheat land. When transplanted to other lands, it dege-

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nerates. It is as yet doubtful whether the wheat derives its red brown hue from the soil, and whether or not it will lose it when sown in a different kind of land. If this change does take place, it is very gradually effected.

The kind which is usually sown in the autumn, and occasionally in the spring, is the yellow wheat. For some time this species had been wholly discarded by scientific agriculturists, and the white wheat adopted in its stead, on account of the latter yielding equally well, and likewise fetching a much higher price when once it began to be appreciated. It also forms a whiter flour than the yellow wheat, even when less carefully sifted; it is purchased chiefly for the use of the navy, and for ship provisions, and fetches a very high price. It would, in all probability, have been pretty generally introduced, had not the winter of 1803 proved it to be exceedingly delicate. In many countries it could not resist the long period of dry, cold weather, which then occurred, and perished, while the yellow wheat bore the severity of the temperature very well.

There are two kinds of white wheat. In one the husk is smooth; in the other it is covered with fine hair, which gives to the ear a velvety appearance. The English pay very great attention to this difference, as, according to them, it is not only invariable, but very important. The former kind they term *egg-shell wheat;* the latter, *velvet-ear*. They consider that the former answers better in damp situations than the latter, which, from its rough husk, attracts too much moisture, and, consequently, is exposed to the smut, and dries very slowly: on the other hand, however, the *velvet-ear*, or that which has this uneven covering, is considered as best adapted for dry elevated situations, because it is better able to bear continuous heat than the other, does not dry up so soon, and is not so liable to contract. This opinion is doubtless well founded, since the little hairs with which its husk is covered may be regarded as suckers. A long while ago, I received some of this rough white wheat from England; I have since met with it in this country, and was informed that the seed from which it originated came from the principality of Dessaw; this also had, however, most probably been brought from England originally:* it has no beard. If any one kind of wheat more than another ought to be called English wheat, it is this, and not the *triticum turgidum*.

That variety which is so much esteemed in England, and which bears the name of *hedge-wheat*, and has been produced by the seed obtained from some large plants found near to a hedge, the which have become multiplied and perfected by careful cultivation, is by no means a distinct species, but will, if cultivated in the ordinary way, soon be found to decline and degenerate.

In the same manner, autumnal wheat is distinguished from spring wheat by cultivation and art, rather than any botanical difference.

As it is of little consequence whether rye or wheat is sown for the autumnal crop, the question must be decided by the adaptation of the soil to one or the other of these products. Argillaceous soils should always be reserved for wheat; whereas sandy soils will be found best suited to rye. It may generally be admitted as a principle, that land which contains more than fifty-five parts in a hundred of sand, is by no means so well adapted for the production of wheat as it is for that of rye. There are, however, circumstances which tend to modify this principle, as, for instance, the position of the land, the sources from which it derives its moisture, &c. Where, from situation, the soil is inclined to be damp, it will be better adapted for the cultivation of wheat than for that of rye, even though it may contain from sixty to sixty-five parts in a hundred of sand; for the dampness, which compensates for the absence of clay, would be exceedingly injurious to rye.

The success of autumnal wheat can never be depended on, unless the ground upon which it is sown is tolerably stiff. Light, loose land, devoid of clay, may, if it is suffi-

* I found it, in 1811, sown in a marshy, damp soil; at least one-third of the crop was suffering from smut.

ciently moist, and contains an abundance of humus, produce wheat; but the crop is always casual and uncertain, because such a soil does not afford a sufficient holdfast to the roots, especially in the winter.

The greater the proportion of clay a soil contains, and the less proportion of sand, the more is it qualified for the production of wheat, and the less for that of rye. If land containing but little sand has fifteen parts in a hundred of lime, it may be considered as good wheat land; this lime tends to give it a degree of divisibility without at all injuring its consistency, and entirely prevents the development of that acidity which is so injurious to wheat.

But in order to ensure the success of wheat crops, the land must contain a sufficient quantity of nutritive particles to feed plants which require so large an amount of nourishment as these do. Argillaceous soils, abounding in humus, and of a blackish brown hue, are consequently those, of all others, which bear *the richest* crops of wheat. Land which is *naturally less* fertile may be ameliorated through the *medium* of manure; clayey soils, however badly and scantily they may be manured, always bear better crops of wheat than of rye, especially when situated in a cold damp place; this is the reason that fields situate on mountains are always more profitable when sown with wheat than they are when sown with rye.

Wheat will not flourish if the soil contains any free acid; whenever I have met with land which, although apparently in every way adapted for the cultivation of wheat, yet failed to yield good crops, I have always found, on examination, that it contained a sensible quantity of acid.

Such land may be rendered fit for the production of wheat by ameliorations of lime, marl, or ashes, or by paring and burning the surface; after this last-named operation has been performed, it will prove equally adapted for barley, peas, or clover.

It may then be considered as an undeniable fact that argillaceous lands can be applied with far greater advantage in the production of wheat than in that of rye. But nothing but local circumstances and the state of the temperature can determine to which kind of grain a medium soil or thin clay, containing from fifty-five to sixty-five parts in a hundred of sand, is most favourable of production. In those countries where wheat constitutes the sole food, and rye is but little valued, the former is usually cultivated; but with us it is quite the contrary, wheat is only cultivated when particular circumstances combine to raise its price far above its relative value as regards rye. For although, on the average, such a soil when kept in good condition may produce a crop of wheat of far greater value than one of rye would be, it is well known that wheat exhausts land very much, and that its enervating effects are sensibly evident upon the succeeding crops; besides wheat straw furnishes less substance for the reproduction of manure than any other. Thus wheat tends to enfeeble the whole system of the rural economy, especially when repeated crops of it are raised. Prudent agriculturists, therefore, content themselves with growing rye, from which they derive certain if not large profits.

Wheat is generally sown on fallow ground, or, if the soil contains little natural fertility, on manured fallows. Occasionally, when the land is very strong and rich, this practice is departed from, as there is then some danger of the corn being lodged; and a crop of cabbages, or some other produce of a like nature, is first raised from the land. Some agriculturists do not sow wheat even after this preliminary crop, but substitute for it winter barley, to be succeeded by a fallow or a fallow crop, and then sow the wheat. Others who are unacquainted with the advantages of the alternate cultivation of various crops, and attached to the triennial rotation, sow barley on the manured fallow, and then wheat. This barley is very frequently laid, but they are of opinion that it is less injured by this circumstance than wheat would be. The wheat which is then sown, so far from being very luxuriant and vigorous, is often exceedingly poor and weak. Barley forms by no means a good preparation for wheat; indeed, the soil must contain a superabundance of nutritive matter to admit of the wheat succeeding at all; on poor land it yields but a very thin crop. When the land is of a medium quality, wheat is almost always sown on a manured fallow.

This remark applies to *rotations with pasturage* as well as to the *triennial rotation;* and now most persons consider that it is most advantageous to sow wheat on the manured fallow which succeeds the rest, on account of the manure being most efficacious when spread over land which has been left at rest. The doctrine which teaches that a double force is productive of more effect than a single one, is by no means new; but the agriculturists of former days, who acted upon the system of rotations with pasturage, deemed it more expedient to distribute this richness of the soil over a series of years, and accordingly first profited by the amelioration induced by the rest, and subsequently by the manure. By this mode of proceeding they certainly did not obtain such exceedingly luxuriant crops; but, on the other hand, they had less wheat lodged in wet years, and on the whole realized a very considerable amount of produce. On many fields wheat was not then sown at all, while now it is sown as soon as the sward is broken up and manured.

Every fallow which is to be sown with wheat should receive four ploughings, while those which are to be sown with rye need only receive three; for although wheat requires a stiff soil, it also requires that all the nutritious matter should be brought within reach of its suckers, and the hard clods broken and pulverized.

In general, wheat is sown in the spring after turnips or cabbages; for although there cannot be a doubt that these crops take from the land on which they vegetate a great proportion of its succulency, yet as they are never sown but on rich soils which have been plentifully manured, they leave quite sufficient nutritive matter to ensure the success of the wheat. Indeed, these crops tend to give the soil a very efficient preparation for corn; they shadow it with their leaves, and render it loose and friable. Should it be deemed necessary, there is always time enough between the getting in of this fallow or preparatory crop and the sowing of the wheat to plough the land once or twice.

After some weeded crops which have been very plentifully manured, and have grown on particularly rich land, as, for example, tobacco or cabbages, wheat is also sown. The soil is then so loose and clear that this crop can be got into the ground with one ploughing only; and even when sown rather later than usual succeeds wonderfully. Wheat sown after potatoes is, however, always poor and weak; this has been proved to be a fact by numerous well-attested experiments, although some agriculturists insist upon it that wheat crops thus obtained are equally as fine as rye crops would be.

Wheat sown after a crop of vegetables does not answer so well as it would if sown on a dead fallow. Nevertheless, there are cases in which, when thus sown, the crop has far surpassed that which would have been obtained from a fallow. Instances of this are chiefly observed when the weather has been unfavourable to the operations attendant on fallowing, but has greatly assisted in forwarding the growth of the vegetables, the debris of which then render the soil better adapted for the reception of wheat than it was after the fallow. But the soil, after having borne this crop of vegetables, must always be ploughed previously to the wheat being sown, or the success of the crop will be doubtful.

Some persons consider peas to be the best preparation for wheat; others, on the contrary, prefer beans. The latter absorb more nourishment than the former, because they usually yield a much more abundant crop. Should the soil be only moderately supplied with fertility, it will, after having borne beans, be too poor to yield a good crop of wheat; peas would, therefore, have been better, as they would impoverish the land less. But, where the soil is rich enough to furnish the requisite nourishment to both crops, I think beans an excellent preparation for wheat. The rotation which has from time immemorial been followed in Kent, viz., wheat and beans alternately, proves the justice of my opinions: a similar rotation has also been adopted in various other parts of England. I have seen very fine wheat grown on land which had previously borne beans sown in rows.

Lastly, the best and most successful way of obtaining good wheat crops, is to sow the grain in broken-up clover land; but, in order to grow it on land which, from its friability, appears not to be at all adapted for wheat, the best way is to sow the grain after one single ploughing. It not unfrequently happens that the produce then yielded infinitely surpasses that of crops raised on fallow ground, and it is said to be less exposed to smut and other diseases. But these advantages will not be obtained unless the clover has been thick, vigorous, and unmixed with weeds; the second cutting taken sufficiently early to admit of the shoots acquiring a height of eight or ten inches; and, lastly, the whole of this ploughed in without having been pastured. These conditions can rarely all be fulfilled unless the soil happens to be particularly good, and great attention is paid to the whole of the cultivation. In breaking up the clover, care must be taken that the furrows are drawn straight, and the furrow slices well laid over. The best way to ensure success is to make use of a light plough. The ploughing must be performed a month before it is necessary to sow the grain, in order that the clover may have time to become decomposed, and the ground equalized. The seed may be covered by harrowing; but the best plan of proceeding is to make use of the extirpator for this purpose. This mode of sowing wheat on a single ploughing is very seldom put in practice, except on clover land of one year's growth; nevertheless, if the clover is thick and vigorous, has been mown without being pastured, and the soil is clear and loose, the same course may always be pursued. Where, however, the contrary is the case, the land must be ploughed three times before it will be fit for the reception of the seed; consequently, only one cutting of clover can be obtained from it that year. General experience tends to prove that it is highly injudicious to sow wheat upon its own stubble. Tull, and some of his imitators, certainly sowed wheat year after year in the same field; but then he only derived a crop from one-half of the surface, and fallowed the other half. The same may be observed with regard to the Belgian system; but even there wheat is seldom or never seen on the same land for two consecutive years. Wheat sown after barley is always feeble: this plan of proceeding will only be found to answer on very good strong land. Various experiments have appeared to prove that oats form a better preparatory crop for wheat than barley does. White wheat is considered to succeed better after brown, and *vice versa*, than the same kind does when sown in two successive years. It may, however, be regarded as a general principle that it is in the highest degree injudicious to sow wheat on the stubble of any other crop of corn. Wheat sown after linseed rarely yields more than a very scanty crop, but it answers much better after hemp. I have, however, seen a very fine crop of wheat produced after linseed sown on ameliorated land which had only been ploughed once.

There is no kind of corn in which the success of the crop depends so much on a careful selection of the seed as it does in wheat, for bad or defective seeds contain the principle of smut or diseases equally as fatal. We shall have occasion to enlarge more fully on this subject by and bye, and will then enter into a consideration of the best method of purifying the seed.

Wheat is usually sown later than rye, not because it would be injurious to commit it to the ground earlier (for the experience of several countries teaches us that it may be advantageously sown in August), but because wheat is better able to bear a late sowing than rye; and, consequently, the latter is got into the ground first. Wheat also suffers less than rye when sown during wet weather; and this accounts for dry weather being always chosen for the purpose of getting the latter into the ground, while the former is sown either in wet or dry weather.

Wheat, when sown in an argillaceous soil, can bear a covering of earth three inches deep, and where the land is light and loose this depth may be increased to four inches: it germinates very well at this depth, and shoots up without difficulty. It may, therefore, without danger be covered by a superficial ploughing, provided that the soil is properly loosened, and not too damp: this plan of proceeding is peculiarly adapted to sandy soils, as the young roots of the corn are then enabled to take a firmer hold, and are less liable to suffer from the effects of drought. The practice cannot, however, be carried into effect upon broken-up clover land.

Wheat withstands the wet weather usually met with in winter better than rye, and often shoots up again, even in places where, from there having been standing water, it seemed to have entirely disappeared. But, notwithstanding this, the fields should always be very carefully drained.

After an unfavourable winter the wheat will often look very bad, even up to the beginning of May, and only a few plants scattered here and there will be discoverable. The farmer must not, however, on this account despair of the crop, but must wait until some weeks of continuous warm weather shall have given the crop a chance of recovering itself; should this fail to produce any beneficial effect upon the appearance of his fields, he may then have recourse to the plough, and break the land up. An account of some very interesting observations made on this point at Mecklenburg will be found in the "Annals of the Agricultural Society of Mecklenburg," vol. ii. 1803, p. 169.

Wheat requires more careful and continuous attention throughout the whole period of its vegetation than any other kind of cereal, and it amply repays all the labour and pains bestowed upon it.

If it is only just beginning to vegetate in the spring, and the soil is tolerably dry, nothing will prove so beneficial as to pass a harrow, having iron teeth, over it.* By this means the crust will be broken up which has been formed over the surface of the ground, during the past winter, and the superficial stratum of the soil brought into direct contact with the atmosphere; the coronal roots which shoot about this time then find around them a soil recently impregnated with atmospheric matter, which tends greatly to favour the growth of the plants, while those weeds which shoot up at this season, will all be then destroyed by the action of the harrow. A fine day should be chosen for the performance of this operation, which must be boldly undertaken. If, after this, the field has every appearance of having been newly sown, and no green leaf, or, indeed, anything but the bare ground is perceptible, then there is every reason to hope that the operation will be attended with success. Should a few torn leaves or blades of wheat be perceptible, it will not matter, provided that the plants themselves are not torn up. After a lapse of eight or ten days, if the weather is favourable, the plants will be seen to shoot up afresh, and the field will present a much better and greener aspect than it did before the operation. The farmer may be pardoned anything but the omission of performing this important operation at the most favourable and propitious moment. Everything else should be set aside for the time being, in order that all the teams may be brought to work in harrowing the corn fields. The remarks relative to this point, which will be found in the "Annals of the Agricultural Society of Mecklenburg," are well worthy of perusal. No general rule can be laid down respecting the amount of draught power which should be attached to the plough, so much depending on the tenacity of the soil. The harrowing must be so complete that the field shall be entirely covered with a layer of loose earth, and those clefts which are usually formed in argillaceous soils when they become dry completely filled up. This operation need not be confined to tenacious clayey soils, but may be

* Or else a rake with iron teeth.

applied to any land which is sown with wheat, without fear or hesitation; the only difference which need be made is, that light soils should be less violently harrowed.

There cannot be a doubt but that the operation of weeding, by means of which all the intervals or spaces which separate the plants are freed from weeds, cultivated and loosened, is exceedingly beneficial to the crops. But it is rarely performed, excepting in places where the farmer himself and his family work; or in localities where the labourers are accustomed to it, and execute it as task work. When the men are skilful in the performance of this operation, it is not nearly so difficult or laborious as at first sight it appears to be.

That species of cultivation bestowed through the medium of the hand-hoe is even more beneficial to the crops than weeding; it is not only more rapidly performed and less fatiguing, but the surface of the soil is thus loosened and ameliorated, and the earth raked up round the plants with less difficulty, and the plants themselves easily thinned, where they grow too closely together.

I shall presently have occasion to describe that kind of cultivation which may be bestowed by means of the horse hoe, and which can only be applied to crops sown in rows or lines, but which is so beneficial to wheat.

When, on a very fertile soil, the wheat plants, which before appeared to be rather few and far between, suddenly shoot up, and put forth vigorous leaves and lateral shoots, there is every reason to fear that the vegetation will become too luxuriant and the corn lodged.

There are two ways of avoiding this evil; viz., either by cutting off the tops of the plants, or by turning sheep on to the corn fields.

When the first of these two is adopted, the tallest leaves are cut when the vegetation of the wheat is advancing, and it puts forth leaves and covers the soil; care must, however, be taken not to touch the heart of the plant. It is of the utmost importance that this operation should be performed by careful persons accustomed to mowing, and never by those to whom the portions cut off are to be given as fodder for their cattle; because, where such is the case, they are very apt to cut off too much, in order to obtain more food for their animals, and thus materially injure the wheat. The practice of cutting the leaves of the corn at this season, tends to check and temper the luxuriance of the vegetation. It must never be undertaken without due consideration and reflection. The farmer must be thoroughly acquainted with the fertility and other qualities of the soil, and must carefully weigh all the appearances and probabilities from which any deductions relative to the weather and temperature which may be anticipated may be drawn; which latter are often very deceptive, since a state of temperature highly favourable to wheat is frequently succeeded by one which retards the vegetation of the crop so much, as to create regret that anything should have been done to weaken it. Nothing but practice and attention can enable the farmer to avoid frequently falling into great errors on this point. When the wheat plants are interlaced, the leaves of a dark green hue and intermingled with one another, when its shoots are full and vigorous and tall, some check should be given to the vegetation, if the farmer would avoid the danger of its being lodged; but where these appearances are not visible, it should be let alone.

The period for pasturing sheep upon wheat, usually, is about the latter end of April. This practice should, however, only be had recourse to when the soil is particularly fertile and the plants cover the ground with a thick layer of green. Where this mode of reducing the luxuriance of the vegetation is put into practice, a great number of sheep should be turned upon the land at once, and suffered to eat down the young plants nearly to the ground; it is highly injudicious to turn only a few of these animals on at a time, with the view of gradually producing the required effect. As soon as the sheep have performed their office, they must be removed, and the plants allowed to recover themselves. I consider that the best mode of proceeding is to cut off the tops of the plants; this, however, should be done only where the soil is very rich.

The operation of which I am now about to speak is somewhat analogous, although it should on no account be confounded with the last mentioned one; I allude to that in which the weeds that have shot up above the wheat, and rye plants springing from seed which chanced to be among the wheat or was contained in the manure, are cut down. This must also be very carefully done, and the wheat itself on no account touched.

Inclement and cold nights are more unfavourable to wheat than to any other kind of corn; they invariably check the vegetation of the crop, and almost cause it to retrograde. But the plants soon recover themselves, especially if a period of fine weather succeeds; a very few days will often suffice to make them again look green and healthy. Up to the time when the blades shoot and the ears become developed, wheat thrives best in a warm temperature varied by continuous rains, as such weather is most favourable to the growth of its lateral shoots. When it is about to flower, dry, warm weather is most favourable to it. After the grain is formed and matured, the most beneficial temperature is a moderately moist one; continuous drought and warm winds mature the grain too quickly, and it is then not so perfect as it would have been under opposite circumstances. Heavy rains are exceedingly injurious, as they tend to engender smut in the grain.

Wheat which is intended for sale should be cut before it comes to full maturity, otherwise it assumes a dusky appearance, and does not yield such white flour; many persons endeavour to remedy this by moistening the grain, but buyers always reject such wheat, especially if the market is tolerably stocked. Besides, wheat is always disposed to shed its seed; in dry, windy weather, there will be some danger of a great deal being wasted if the crop is allowed to get too ripe. The exact period at which the harvest should be commenced must, therefore, be carefully chosen; and this has arrived when the grain has formed its farina, ceases to be milky, and yet has not hardened. Although wheat usually ripens about a fortnight later than rye, it frequently happens that it is fit to be cut before the rye crops have been gathered in. When this is the case, the rye should be left and the wheat gathered in, because if it is neglected the loss will be far greater than that resulting from any neglect of the rye would be; only that portion of wheat which is intended for seed should be suffered to become completely or dead ripe, and this must then be gathered in as carefully and quickly as possible.

When wheat is sown in a good soil, and the weather is favourable to its growth, it yields the largest amount of produce of any kind of grain, in nutritive matter at least, if not in bulk; and then oats is the only kind which equals, or much less surpasses it. When only a moderate degree of cultivation is bestowed, it will often yield twenty-four bushels per acre, provided that the land is good, and the weather, on the whole, favourable. In England, wheat sown in drills, and carefully weeded, will often yield a much larger crop. Twelve bushels are usually regarded as a good, and eight as a bad crop. On good wheat land, carefully cultivated, the average amount of produce is about ten bushels per acre per annum.

But we shall regard wheat as still more advantageous when compared with other grain, if we come to consider the value of its produce. This value is by no means conventional, but is, on the contrary, founded upon the nature of the grain. The usual weight of a bushel of good wheat is from 84 to 96 lbs., and this weight contains a far greater proportion of nutritive parts than an equal number of pounds of any other kind of grain; these parts, too, are in themselves superior, more strengthening, and energetic. It also contains gluten, that substance so analogous to animal matter, in much larger quantities, and in a much purer state than it is contained by any other kind of grain, and, consequently, wheat is most adapted for animal food. Besides, it contains particularly good starch. From the intimate combination of its particles, a far more digestive, nourishing, and agreeable kind of food may be manufactured from wheat than from any other kind of grain.

The condition and properties of the soil, as well as the kind and quantity of manure used upon it, has a considerable effect upon the relative proportions of the constituent parts of this kind of grain. Wheat grown on land manured by fresh sheep or horse-dung, or by these animals being pastured on it, always contains a very large proportion of gluten, which renders it unfit for the fabrication of beer or brandy, while it makes the best flour and bread. According to Hermbstaedt, the proportion of gluten contained in wheat varies from five to thirty parts in a hundred. Besides this, all kinds of wheat have not an equally thick husk. This difference arises partly from variety and species, and partly from the nature of the soil; damp soils always make the husk thicker. The thickness of the husk is always exactly in an inverse ratio with the weight of the grain.

In proportion as wheat requires, and, under favourable circumstances, absorbs a larger quantity of nutritious matter from the soil than any other kind of grain, so in like proportion does it exhaust the land. In those calculations which I have already given, and which, although hypothetical, are based on experiments made for the express purpose of throwing some light on this point, I have stated as a general average that wheat absorbs forty of every hundred parts of nutriment contained in the soil.

It is very probable that in the formation of its vegeto-animal gluten, it absorbs a large portion of animal humus, or, at any rate, requires a large quantity of azote; and that animal manures suit it much better than those which are purely vegetable, and which suffice for any other kind of cereals. Lime and alkalies might answer as well; I say might, for as yet we have no positive experiments on this point to prove that they do. Most certain, however, it is that wheat exhausts land much more than any other kind of grain; both general experience and individual experiments tend to attest the truth of this fact. The cultivation of it should, therefore, be restricted within certain limits, especially where the land is light and friable, as in these cases the humus contained in it is much more easily absorbed than it would be from a clayey soil. Where the circumstances of the undertaking are such as to admit of the exhaustion being repaired by the addition of fresh manure, the farmer can be guided by his own interest or pleasure on this point.

Wheat usually gives double the weight of straw that it does of grain. On elevated or mountainous lands, something less—and on low, flat grounds, something more than this average may be anticipated. The weather has a considerable influence on this proportion in wheat as well as in all other kinds of grain. Wheat straw is more nutritious than any other; but it is not so well adapted for litter as rye straw.

Spring Wheat.

This kind is not distinguished from autumnal wheat by any botanical characteristic, but simply by a property which has been artificially communicated to it, and of which it may be deprived by a change in the mode of cultivation, viz., that of coming more quickly to ear. It is not always bearded. It is well known that spring wheat is often made to become autumnal. This cannot, however, be so easily effected with some varieties as it may with others.

Various kinds, both with and without beard, have been cultivated. The beardless varieties have generally been considered as the best. It will be impossible to decide whether or not certain kinds of wheat brought from Tunis or Candia, and cultivated by Fischer, at Dunkelsbühl, are deserving the high praise bestowed on them, until some more conclusive experiments have been made on the subject.

Spring wheat does not require so stiff a soil as autumnal wheat, but thrives well on light land, provided that this land is not too dry, and is also rich in humus and manure. It also must be well tilled, pulverized, and cleared. The fields in which spring wheat can be sown with most chance of success, are those in which weeded crops have been cultivated, and where autumnal wheat has not been sown, either on account of the weeded crop having been got in too late, or because it in general forms a very bad preparation for spring corn.

Spring wheat succeeds better than autumnal wheat when sown after potatoes, provided that the soil is rich, and not too dry. In general, it takes the place of large barley. Many agriculturists consider it to be exceedingly advantageous always to sow spring wheat instead of large barley after weeded crops, where the alternate rotation is pursued, because its produce will invariably be found to be greater than that of barley; but the result has not justified the opinion, excepting where the soil has been rich, and abundantly stored with humus. There can be no doubt but that spring wheat absorbs more nutritious matter than barley. Where the soil is poor, the crop fails; and where it is rich, it thrives and exhausts it. Autumnal wheat, which is not sown until two years afterwards, and even the succeeding rye crops will yield but a scanty produce, unless the exhausted land is ameliorated by a good manuring.

To these remarks it may be added, that spring wheat is very apt to fail in our climate. Cold, rainy, and even dry summers are injurious to it. In those years when, from a succession of alternately warm and dry weather, barley thrives very well, at least half the wheat ears will be found to be destroyed by smut. This disease attacks spring wheat much more frequently than it does autumnal wheat; whereas caries seems to be peculiar to the latter. This circumstance may possibly account for the fact, that nothwithstanding the praises lavished on spring wheat, it is but little cultivated in the north of Europe; indeed, it is seldom met with there, excepting in those places where autumnal wheat is not cultivated.

The period for getting the seed into the ground occurs sometime between the middle of April and the middle of May; it should not be sown so early as spring rye; it does not in general ripen until September. The grain is smaller, and does not make so much show as that of autumnal wheat. The husk is usually stronger, and the grain lighter, although the farina which it yields is fully equal in quality to that of autumnal wheat. Some persons are of opinion, however, that it does not answer so well as the latter when used for the purpose of making bread, but speak very highly of its qualities when employed in the manufacture of starch.

When wheat is scarce, buyers frequently do not object to giving as much for spring as for autumnal wheat; but otherwise they reject it, and not entirely without reason, on account of the smallness of the grain, and that it fetches but a very low price.

Spelt.

Triticum spelta is chiefly distinguished from wheat by its husk, which is flat, and round at the end, and encloses and retains the grain so firmly that it cannot even be separated from it by threshing; recourse is, therefore, obliged to be had to a mill. It is, doubtless, this circumstance which prevents this useful grain from being cultivated in the north of Germany, where the millers are unacquainted with the means which must be taken for the purpose of freeing the grain from the husk or chaff.

There are various kinds of spelt; some with and some without a beard; some grown as autumnal, some as spring corn; and these varieties differ in hue and colour.

There is no difference between the cultivation of wheat and that of spelt. The latter is stronger, and less liable to fail during winter when sown in damp situations than wheat; it grows higher, is not so easily laid, and does not shed its grain so quickly; neither does it require so rich a soil. It is, like wheat, subject to smut; but does not suffer so much from the ravages of that disease. When the grain is separated from the husk, it is quite equal to wheat in weight and value; some persons even assert, that wheat does not yield so good flour, or make such nice bread as spelt.

It is either preserved in the husk or separate from it; it is, however, seldom separated from it, unless it is to be used immediately, as it keeps better in that covering, and is less liable to be injured by vermin, or become heated. Sometimes it is sent to market in the husk, at others not until freed from it; in the former case, it only fetches one half as much as it does in the latter.

It is sown in the husk, but twice as thickly as wheat. In the south of Germany it is more generally cultivated than any other kind of grain.

When in the husk, it may be advantageously used as provender or forage for horses; and in places where the millers are not acquainted with the proper mode of separating the grain from the husk, this is the best if not the only use to which it can be applied.

One-grained Wheat (Einkorn of the Germans).

Triticum monococon, or Saint Peter's wheat, very much resembles large flat barley, in its general appearance and in the form of the ear, but it has not so much beard. The grain is equal in value to that of spelt; but is much smaller. It is cultivated both as spring and autumnal wheat, on land which is regarded as too poor to bear spelt; also on the most remote crop divisions, and in places at a considerable distance from the farm buildings. It is most frequently met with in Wirtemberg.

The species known to botanists *triticum polonicum*, Polish wheat, Valachian wheat, Surinam wheat, &c., has been derived from the *triticum monococon*. This variety differs from all others in the form of its ears and grain, both of which are long and narrow. The quality of the farina is about half way between that of wheat and rye flour. It ripens late, when, as is usually the case, it is cultivated as spring corn; in cold summers it rarely attains to maturity. It is much prized as an ingredient in soup, after having been ground, and is said to approach nearer to the nature of rice than any other known production. It has not yet been made a marketable commodity among us, nor do we expect to see it so.

Smut, or Caries in Wheat (Brand).

In the cultivation of wheat, and other species of the family of *triticums*, there is, in some countries, nothing that militates so much against the success of the crops as those diseases termed "smut" and "caries;" and, consequently, no subject has so deeply engaged the attention of agriculturists, as the means of guarding against this evil. Numberless volumes have been written on this subject in every known language; but, as yet, very little light has been thrown upon it, on account of the disease having been confounded with others which are essentially distinct and arise from totally opposite causes, or else because each author has given his own views and opinions only, without reference to those of others, and these have been too frequently founded on narrow and partial views of the subject.

We shall commence by drawing a line of distinction between these two diseases, both of which are, in Germany, comprehended under the denomination of *brand;* the first, or *brand* properly so called, is that disease which the French designate "*nielle,*" and the English "*smut.*" It entirely destroys the substance of the grain, and nothing remains in the husks but a blackish brown dust. This disease is, doubtless, the same as that which develops itself in various kinds of grain, and especially in barley and other gramineous plants, and which is frequently designated "soot," because the powder to which the grain is resolved so much resembles that deposited by flame, and is, in fact, fully capable of supplying the place of actual soot in the preparation of the black colour used in painting. This disease attacks wheat more frequently than any other kind of grain, and often destroys the greater part of the crop. I have seen a field of spring wheat, sown on a recently manured sandy soil, in which I could not discover one single perfect grain.* It often shows itself before the ears have begun to form, and traces of blackness and disease are visible even in the very marrow of the plant. Where this is the case, however, the plants grow up to their usual height, the ears attain their full size, and even look healthy, although they are thin and poor. The husks are greener, shorter, and rather more rounded. When the ear is approaching its full size, the black hue becomes perceptible through the husk; which latter is not, however, so thin as in barley, where it bursts before the formation of the ear is nearly completed, and sheds a black dust. When the wheat has attained its full growth, the husks burst, and the rain and wind wash away and carry off the black dust, without its injuring or discolouring the sound grain. But where the wheat is cut before it has become perfectly matured, and the weather is damp, the powder remains in the husk, is carried to the barn with the wheat, and there beaten out by the flail. In this manner the sound wheat becomes blackened, because this black powder attaches itself particularly to that slight tuft of hair or down which exists at the extremity of wheat, at the bottom of the line or cleft which passes down each grain. This discolouration, notwithstanding which the grain remains uninjured, is called the tip (*le bout den nagelbrand, der spitzbrand*), and is very often confounded with caries. But it is neither more nor less than a mere external discolouration of the grain, and has not the slightest effect on its soundness; it cannot, however, be denied that it may tend to give a black shade to the flour, unless the grain is very carefully cleansed before being sent to be ground. There are two ways of cleansing the grain: the first consists in washing it, and does not injure it in the least, provided that immediately afterwards it is carefully dried; the second consists in threshing the grain, mixed

* From this it would seem that this disease is much more frequent and dangerous in the north than it is in the south. I have never seen it commit anything like the ravages above described, either in Italy, France, or Switzerand.—FRENCH TRANS.

with barley chaff or dry clay, and subsequently separating it from these substances by passing it several times through a winnowing machine.

The disease itself is not hereditary, nor is it transmitted through the medium of the seed; it is engendered on moist or exceedingly rich land when the weather is damp and warm. It is true that an imperfect grain will produce only a feeble plant, and such an one will undoubtedly be more liable to take disease than another would be; but still the disease is not hereditary in the actual sense of that word, and for this reason: those grains which actually are attacked by this disease are completely destroyed, and the powder which falls from them adheres merely to the exterior of the others, and does not injure them in this point of view. Sound grain which is only discoloured by this smut powder will always produce healthy crops, provided that there are no other circumstances attending it which lead to an opposite result. My own experience, as well as that of others, tends to prove that not only the ear, but the whole of the grain is attacked by smut. No washes can impede the progress of the disease; the best way of preventing its attacks is to see that the seeds are sound and fully matured, the sowings properly performed, the soil thoroughly drained, and that species of manure applied which is best adapted to its nature. The weather and temperature exercise considerable influence over this disease; in one year it will be scarcely heard of, while in another its results will be most fatal. There are some particular fields in which the crops frequently suffer from caries, and where smut is unknown; while in others the former disease may be guarded against, while the latter can never entirely be eradicated.

Caries does not wholly destroy the consistence of the grain, nor does it injure its form; nevertheless, its blackish-brown hue, its smell, and its nauseous flavour are sufficient evidences of change and deterioration. This disease does not appear to be developed until the grain begins to form; no traces of it are perceptible until after the period of flowering. The ears look sickly, palid, and weak, and eventually become covered with dark-coloured specks. Caries deteriorates the sound grain when any of the diseased ones are suffered to get amongst it; but as those which are attacked are lighter than the others, it is easy to get rid of them by the process of winnowing. When this operation is carefully performed, the greater part, if not the whole, of the diseased grains may be separated from the sound ones. Where only a few are left, they do not spoil the flour or render it injurious to health; but where there are any considerable number of them, they communicate a disagreeable flavour to it, and render it unfit for any kind of use. The grain even becomes less adapted for the use of brewers and distillers, and deteriorates from the quality of the brandy made from it.

The cause of caries, at least of the most virulent variety of this disease, exists in the seed, and is hereditary. This is sufficiently attested by the fact, that many agriculturists whose crops have year after year suffered from its ravages, have only succeeded in escaping from this evil by a most careful selection of the seed, and by following it up with other suitable preventive proceedings: but no sooner have they ceased to observe these precautions, than the disease has returned as badly as ever.

When perfectly ripe grain which has never been attacked by this disease, has been thrashed previously to being sweated in the stack, is then spread over the granary in thin layers, carefully moved about to expose it to the air until dry, and then sown, the farmer may make himself perfectly easy respecting the success of his crop, at least so far as regards this disease. All danger may frequently be avoided in grain a year old, which has been properly treated and carefully preserved.

If, however, this cannot be entirely depended upon, there are various means of preventing or lessening this evil, all of which are attended with greater or less success.

Some persons consider it as sufficient to wash the wheat in clear water, provided that, while doing so, care is taken to remove all the light and diseased grains, which invariably rise to the top.

Others regard salt water as more efficacious; the light grains being then more sure to swim on the top: besides, it cannot be denied that salt also acts beneficially in another way.

The most really efficacious preventives have been found to be lime, ashes, common salt, Glauber's and other salts, alum, sulphate of iron, and arsenic. These substances are used either singly or combined, in various forms and ways.

The following is the most usual way of applying lime:—One bushel of recently slacked and pulverized lime is considered as sufficient for twelve bushels of seed. The grain is washed with cold water, from which the chill has been taken: some agriculturists use urine. It is thrown into this fluid and well stirred about until all the light grains float on the surface; these must be skimmed off and thrown aside as useless. The wheat thus steeped should then be drained for a little while, and afterwards powdered with the newly slacked lime; it should then be left untouched for eight or twelve hours, and then stirred up thoroughly, spread out in thin layers over the floor, and left to dry: it must not be put into sacks until thoroughly dry. Many agriculturists take equal parts of lime and alkaline ashes, and thus produce a caustic alkali, which mixture whether viewed in a theoretical or practical point of view, appears to be highly efficacious. Some persons also add a greater or less proportion of common salt. A wash is also made composed of lime ashes and urine, to which common salt is occasionally added, and the grain watered with it. There are various manipulations and modes of proceeding in these cases; and, although each person attaches particular importance to his own plan, they are all much the same in point of effect. The chief thing to be attended to is to see that these pickles are made as strong and active as possible, and that the whole of the grain is so thoroughly stirred about, that each individual seed receives its due share.

The grain must be left under the influence of this mixture for a certain time, and until a slight degree of heat is perceptible, and then spread out and exposed to the air. Some persons regard kitchen salt as exceedingly efficacious, and, consequently, depend chiefly upon it: but the best authenticated and most numerous experiments tend to prove that no substances so fully answer this purpose as lime and ashes; and in most countries these are the cheapest which can be obtained.

Solutions of vitriol and alum have been very highly recommended; but as there are as yet no authenticated proofs of their efficacy, we shall not put them on a par with the other matters.

Arsenic is a very efficient, but also a very dangerous substance, to make use of, and, when employed, must be confided to the care of some person who is perfectly aware of the frightful effects of this subtle poison.

Although these two diseases, smut and caries, are completely distinct in their nature, it not unfrequently happens that both are found existing in the same field; and although it has been proved that the principal cause of caries is in the seed, and that by a careful selection or treatment of the seed it may frequently be eradicated, yet it must be confessed that it will often be engendered, even where the seed has been perfectly sound, by various causes which exercise a peculiarly pernicious influence over vegetation; and, consequently, there is no certain means of guarding against it.

RYE.

Secale cereale (common rye). Of this grain we have but one species, and all its numerous varieties are distinguished by no botanical characteristic, but merely by some difference in their nature, occasioned by peculiarities in the mode of cultivation.

Autumnal and spring rye acquire the properties that give rise to these appellations, in the same way as autumnal and spring wheat do: we have already described this. The following are the properties of autumnal rye: it remains longer in the ground, grows more bushy, and does not put forth its stems or seed stalks until late in the season. We have one variety which came originally from the Russian provinces on the shores of the Baltic, and which has all the properties of autumnal rye. Those varieties known by the names of *Archangel rye*, *Norwegian rye*, *St. John's rye*, &c., are one and the same, and no dissimilarity between them can be discovered.

I cannot yet make up my mind whether or not the kind termed *Wallachian rye* is of a different nature. It is more than probable that there has been some mistake respecting it; for fifty years ago Siberian barley (*hordeum cœleste*), was regarded as a species of rye, and called Wallachian rye; and not six years ago some of it was sent to me under that name. The real Wallachian rye has no distinguishing characteristic. Every kind of grain which is for some years subjected to a mode of cultivation similar to that pursued in gardens, and the seed of which has been carefully selected, undergoes some changes in its nature; but it is not difficult to foresee that when it comes to be again cultivated in the open field, the existence of these alterations will be of short duration.

That kind of rye which comes to us from the Russian provinces on the borders of the Baltic, and the German name of which may be translated "bushy rye," is far superior to the others. It resists inclement weather better, grows fuller and higher, is not so easily laid, and when sown on a good soil with proper care, always yields a large amount of produce. It must, however, be got into the ground before the end of September. If sown later, or on poor ground, these advantages will not be so manifest. It puts forth its blade and stems, flowers, and ripens much later than common rye; and in order to have it ready for reaping about the same time as the other crops, it must be sown very early. This variety undergoes no alteration. I have been unable to perceive the slightest degeneration even when it has grown near enough to other kinds of rye to receive the pollen blown from their stamens.

Land containing a large proportion of sand is best adapted for rye, which is the only grain that can be cultivated on a soil containing eighty-five parts in a hundred of sand, or more. With us, land of this nature is always called rye-land. Soils containing less than eighty-five parts in a hundred of sand are also adapted for the production of rye.

The richer the land, the more vigorous and luxuriant will the rye be. This grain, however, answers on poor land, which wheat does not. But this depends much upon the nature of the land. Sandy soils part with their humus so much more easily than clays do.

If an exhausted field or portion of land be left in repose for some years, it will collect sufficient nutrition to enable it to bear a crop of rye, though it must be admitted that it will only be a poor one.

Neither is rye so liable to be injured by any acidity in the soil as wheat or barley would be, and, consequently, it may be cultivated on marshy, or heath and furze land, which has been drained.

Rye may therefore be regarded as the most precious gift of God to the inhabitants of sandy and poor countries; without it, many districts would have been uninhabitable.

The degree of preparation bestowed on the soil, and the nature of the crop which precedes the rye, is not of so much consequence as these points would be if wheat were to be sown. A sandy soil, such an one as is best fitted for the production of rye, requires but three ploughings; while more tenacious soils amply repay the expense of a fourth, by the increased amount of produce which they then yield.

Those preparatory crops which are advantageous to wheat, are equally so to rye when it is sown on the soils on which they can be cultivated. A diminution in the produce of the rye crop is almost invariably observed when it is made to succeed potatoes or linseed.

Rye bears being sown on the stubble of some other grain, or even on its own, much better than wheat does.

It is also well known that in some countries rye is sown three or four times in succession on the same land; but the crops thus raised are so miserably poor that all unprejudiced persons have discarded such a rotation. Not even rich and repeated ameliorations can prevent the produce in grain from falling off sadly, although the straw may vegetate luxuriantly. All those isolated cases which are brought forward for the purpose of proving that the second crop has been finer than the first, and of defending this mode of proceeding, cannot overcome general experience, and might, if investigated, be very easily explained away. New manure, buried a short time only before the sowing took place, and the decomposition of which had been prevented by drought or humidity, would always be injurious to the first crop, while it would favour the vegetation of the succeeding ones.

This mode of proceeding may, however, be excused, where the ground is only fit for the production of rye, and where straw is worth as much or more than grain.

It is true that it is not absolutely necessary to pay so much attention to the choice of the seed for a rye as for a wheat crop; nevertheless, perfect and ripe seeds, free from disease, will always fully repay the attention bestowed on their selection. Rye can only bear a very light covering of earth: if sown too deeply in the ground, and especially where the soil is tenacious, it will often be unable to germinate, and will perish. This is the reason why it is so dangerous to bury rye with a plough: I have experienced this to my cost. If the soil is very dry, and remains so after the sowing has taken place, rye sown in rows may have some advantages over that which has been sown by broadcast, because it shoots up more evenly and equally. But as the kind of temperature which will succeed to the sowings cannot be foreseen, it is always most prudent to have recourse to the harrow, unless the seed is to be buried by passing the extirpator superficially over the ground, which mode of proceeding is certainly preferable to any other.

In our climate, the best time for getting the seed into the ground, is somewhere between the middle of September and the middle of October. In some countries, however, the rye is sown in the open field during the whole of the winter, and even up to the end of February, and at times with great success. This is done to enable it to benefit by the ameliorations bestowed on the land in the winter.

Many impartial observers assert that the latest sowings are those which can be most depended upon; but, on the other hand, the crops are never so large as those obtained from the earlier sowings where they do succeed. The worst period for getting the seed into the ground is from the middle of October to the middle of November. But the *bushy rye*, of which I have already made mention, must always be sown early in the year; in fact, it can scarcely be got into the ground too soon. I have even sown it in the middle of June without its coming up that year. When not sown until October, it grows very feebly; and its lateral shoots, being behind-hand when the ears begin to form, remain poor and weak.

From eighteen to twenty metzen of rye are generally sown per acre. When bushy rye is sown in August or about the beginning of September, from twelve to fourteen metzen of seed will be quite sufficient, if it is sown evenly and regularly. It grows so full and luxuriantly that three-fourths of the plants are choked, and but one-fourth remain. In the spring the fields often look so clear that those farmers who are not accustomed to this grain blame themselves for having been too stingy with their seed. But it would have been just the same if they had sown it more thickly, for in the autumn the plants increase and grow so full that they push against each other; each one puts forth ten or twelve blades or more, and, provided that the soil is rich and the weather favourable, the whole field appears closely covered with a luxuriant crop. As this kind of rye comes up, puts forth its leaves, and shoots much later than any other, it often, in May, appears to be very much behind other crops in point of vegetation, but before June is over it has far surpassed them.

Rye crops are equally as much benefited as wheat by being harrowed in the spring, especially where a hard crust has formed over the surface of the soil; but this tillage or cultivation is never bestowed on it. Harrowing is exceedingly beneficial to rye, even where the soil is of a very sandy nature; but in these cases the operation must be performed with light wooden harrows, and not until the plants have put forth their strong roots. Where these latter have been torn up by frost, especially from a spongy soil, or uncovered by the wind, it will be better to use a roll.

The flowering season is a more critical period for rye than for any of the other cereals; nor can the farmer reckon with any certainty on the success of his crop until this has passed. A white frost coming on about the flowering time may wholly or partially prevent the formation of the grain. This evil frequently only attacks the hedges of the field, or those parts most exposed to the wind, and frequently only injures one side of the ears, viz., that one next to the quarter whence the wind comes. Where this has been the case, the ear loses colour, the points of the husks pucker up, and the husks are found to be empty.

Rainy, damp, or very windy weather, occurring about the flowering season, has a pernicious influence on rye. Occasional showers do it no harm, even when they are tolerably frequent, provided that there are a few hours of warm, sunny weather between each; for during rain the rye closes up its valves, and when the sun afterwards comes out, the anthers spring up so vigorously that the pollen from the stamens covers the field like a thick cloud. But during continuous rains the anthers undergo an alteration in the valves, and rot; or, at any rate, impregnation does not take place; or if it does, the embryo of the grain is putrefied and lost. It is thus that the disease termed the spur or ergot of rye is engendered, and that curious, blackish, violet-coloured excrescence formed which is so well known, and of itself appears to be of no consequence, but when swallowed in large quantities, and especially while fresh, occasions such dangerous and mortal diseases in both men and animals.

Strong, vigorous rye is, however, better able to resist the influences of foreign causes even during the flowering season, than weak and sickly plants are.

When the flowering time is over, it will be easy to discover whether fecundation has been accomplished or not, or, in other words, whether or not the husks contain their grain; it is only necessary to hold the ears up to the light in order to ascertain this, because the impregnated valves appear transparent. But as with rye the flowering process proceeds but very slowly, it is as well not to be in too great a hurry to calculate the probable success of the crop, lest we form an erroneous judgment. When the plant is further developed, the empty husks will be felt on passing the hand over each ear.

Rye is ripe when the straw becomes pale; when its yellow hue fades almost to white, and the knots have lost every trace of green: the grain is hard, easy to be detached, and falls out on the plants being struck or shaken. But Cato's maxium must always be observed with regard to rye: *Oraculum esto biduo citius, quam biduo serius metere* (yet, in your harvest two days too soon rather than two days too late).

On land of tolerable quality, and which from its nature is as well adapted for rye as for wheat, the average produce of these two kinds of grain will be nearly or quite the same in volume. I have, however, never known an instance in which a rye crop averaged more than twenty-two bushels per acre; while much larger crops of wheat are frequently obtained, although it must be confessed that it was from land much too stiff for rye. Twelve bushels may be regarded as a very fair amount of produce; but now and then the crop bareley yields three bushels per acre. Where it is less than this, it may be said altogether to fail; a soil on which this is usually the case, hardly repays the expense of sowing it, and has no nominal value as arable land.

The weight of a bushel of good rye is from seventy-six to eighty-six pounds.

Next to wheat, rye may be said to contain the largest amount of nutritive matter of any of the cultivated cereals. It contains an aromatic substance, which seems to adhere more particularly to the husk, since that agreeable taste and smell peculiar to rye bread are not perceptible in that which is made of rye flour that has been passed through a very fine bolting cloth. The smell, as well as the blackish hue, may be restored by means of a decoction of rye bran in warm water used in making the dough. This substance appears to facilitate digestion, and has a peculiarly strengthening, refreshing, and beneficial effect upon the animal frame.

In places where rye is the chief article of food, the price of this grain is not so variable as it is in others, or, at any rate, it remains more in accordance with the abundance or scantiness of the crops. Foreign demand has in this country but a very indirect influence on its price. With us, rye regulates the price of all other products; and even, by the wages of manual labour, the price of all kinds of manufactured commodities. The circumstances of the locality may be such as to render it more advantageous to grow other products, but the demand for rye is always most regular and certain*.

All soils containing an excessive proportion of sand, and which are not too much exposed to humidity, will be found to bear better crops of rye than of any other kind of grain, provided that the sowings are carefully executed.

This grain exhausts land much less than wheat. In a previous section we have admitted, as a general principle, that rye absorbs thirty parts in a hundred of the nutriment contained in the soil. As this grain yields a

* This remark is chiefly applicable to the north of Germany, or to countries where the inhabitants live chiefly on rye, which is not generally the case either in France or Switzerland.—FRENCH TRANS.

larger quantity of straw than any other, it will, if this straw is reduced to manure, restore a larger portion of the nutriment which it has absorbed than any other; besides, its straw is peculiarly adapted for all the purposes of an agricultural undertaking.

Spring rye is simply a variety of autumnal rye, and may, as I have before observed, easily be changed into autumnal rye. It is generally made use of to replace the latter, when it has been impossible to sow the seed in time; and the ground is not fit for any other kind of grain, and especially for the purpose of deriving benefit from the manure bestowed on the soil during winter. It thrives well on land which is too sandy and too dry for barley or oats. After potatoes or autumnal rye which has failed, spring rye succeeds admirably, provided that it has been sown as early as possible, and in a soil properly prepared for its reception.

Spring rye otherwise seldom yields an amount of produce at all equal to that of autumnal rye, and sometimes altogether fails. Its grain is small, and has a very thin husk; but contains such excellent flour, as to cause it frequently to fetch a higher price than autumnal rye.

It ought to be sown early, viz., either at the end of March, or about the beginning of April; autumnal rye should be sown at the commencement of March. Spring rye is not unfrequently sown on the stubble of autumnal rye, after an amelioration of fresh manure. The soil is only prepared for this kind of sowing during the cold and wet winter months; consequently, dogs-tail grass, bent grass, and other varieties of *agrostis*, multiply rapidly. In general, no fields are found to be so infested with weeds as those in which rye is chiefly cultivated. Such land has hence, often, and very unjustly, been accused of being disposed by nature to produce bent-grass.

BARLEY.

There are five, or, some say, six species or sub-species of barley actually known and cultivated among us—

1. *Hordeum vulgare* ....Common or spring barley.
2. „ *distichon*....Two-rowed or long-eared barley.
3. „ *cœleste* ....Siberian barley.
4. „ *nudum* ....Flat, naked barley.
5. „ *hexastichon*..Six-rowed or winter barley.
6. „ *zeocriton* ...Sprat or battledore barley.

All species of barley require a light, rich, loamy soil, which retains moisture, without, however, suffering from damp; a soil which contains from fifty to sixty-five parts in a hundred of sand, and the rest chiefly clay. If having the former of these proportions it is situated in a dry position, and having the latter in a moist one, it will be rendered still more adapted for the production of barley. This kind of grain, however, thrives wonderfully well on more clayey or stiffer soils, where there is a sufficient quantity of humus to prevent the land from being too tenacious; in short, in land which may be classed among good wheat lands. If the clayey soil contains a certain quantity of lime, and the proportion of clay in it is sufficiently diminished to render it light, without ceasing to be consistent, it will then be peculiarly adapted for barley; and the more so, from the lime purging the soil of its acidity, which latter quality militates against the success of barley. On the other hand, in moist summers, barley will be found to succeed very well on land in which sand is the predominating ingredient, and where it is found in the proportion of from 70 to 75 parts in a hundred; provided, however, that the soil is in tolerably good condition. But during dry summers the crops of barley would fail on such land; consequently its produce can never be depended on. A poor, tenacious, moist, cold, acid soil is by no means proper for barley, nor will that grain often succeed when sown upon it.

Land in which barley is to be sown must be thoroughly loosened and pulverized. When, as usually happens, it is sown on the stubble of autumnal grain, the land must be ploughed at least three times for its reception; but where the soil has been thoroughly loosened during the preceding year by weeded crops, one ploughing will be quite sufficient.

If those crops by which the barley was preceded have not left a sufficient, or indeed a considerable quantity, of nutriment behind, an amelioration composed of manure which has undergone fermentation must be bestowed upon the soil. The tender nature of this grain renders it necessary that the nutrition intended for it should be easy of digestion, and properly prepared for and adapted to its organs.

Barley is not exposed to any particular disease excepting smut, and that seldom injures it much. Those ears which are attacked by it are chiefly the early ones, and then it appears as if the whole field was covered with diseased plants; but when the healthy ears attain maturity, scarcely any trace of the others remain. Pickling and liming have no effect on this kind of smut whatever.

All those kinds of barley which are usually sown in the spring support and require a tolerably thick covering of earth; they may be buried by a shallow ploughing of three or four inches deep, and, in fact, when sown on a very light soil, must be placed at this depth beneath the surface. The land, however, must always first be allowed to get thoroughly dry; with us nothing is more conducive to the success of this grain than a period of dry weather succeeding to the sowing.

Perfect ripe seeds which have not become heated in the granary will always produce healthy plants; they must, however, be carefully sifted and washed, to separate them from those seeds of weeds which usually grow so fast among barley. When this has been done, and the seed is sown early, twelve or fourteen metzen per acre will answer as well as twenty or twenty-two would otherwise do, especially where large barley is sown.

Barley becomes very thick and bushy where it has sufficient space, but when crowded the plants are weakly. Small barley may be sown much more thickly, as the plants are never so full and bushy as those of large barley.

Should heavy rains, which harden the ground, come on after the seed has been sown, a harrow must be passed over the soil as soon as it becomes dry, and before the barley begins to spring up, in order to break the crust, which otherwise often impedes the growth of the plants, being too hard to admit of their forcing their way through.

After the barley has begun to appear above ground, it is often very dangerous to make use of the harrow, as the plants are as brittle as glass. This operation, if performed at all, must be very carefully managed; a light wooden harrow used, and the latter part of the day or the evening chosen for the purpose.

Common, or spring, or small quadrangular Barley.

This species is regarded as best adapted for poor land, and hence has been designated the barley of sandy soils; it will, however, succeed equally as well on clayey soils, provided they are rich and the weather is favourable to it, but not better than large barley. It has six rows, and consequently its ear is in the form of a square, having two wide and two narrow sides.

It is very delicate; a sharp frost will destroy it, and it suffers, more or less, from every inclemency; but it is to be hoped that by being sown generation after generation in our climate, it will eventually become stronger and more robust. This kind of barley occupies but a very short period in its vegetation; in nine or ten weeks' space it comes out of the sack as seed, and returns to it again as new grain; on this account it is frequently not sown until the middle of June. If the weather which then succeeds is warm and properly moist, the crop may turn out better even than large barley, which, from the length of time it takes in vegetating, seldom meets with a constantly favourable state of temperature. But, notwithstanding the most favourable appearances, small barley frequently does not turn out well, especially if there is any lack of humidity at the period when the ear is beginning to be developed; on an average it cannot be said to yield as good an amount of produce as large barley.

In the triennial rotation in which a very imperfect fallow only is bestowed on the autumnal corn, and where the preparation of the fields is not commenced until July, this barley presents the great advantage of not requiring to be sown early; in cases of necessity, even the end of June may not be too late. Thus, in favourable seasons it admits of the land being half fallowed, by which means the soil is pulverized and aerated, and the weeds destroyed; this is often much more beneficial to the land than a late fallow.

The proper period for cutting must be carefully watched and embraced; the plants must not be suffered to attain to absolute maturity, especially the later shoots; because the ears, being supported by very thin and brittle stems, snap off and fall to the ground. When the grain ceases to be milky, but may be compressed between the fingers like wax, and most of the ears are of a yellow colour, the period has arrived for cutting.

If there is then any danger of the grain being shed, it should be mown while the dew is on, and got in with every precaution.

This barley weighs less, and yields much less farina, than large barley. A bushel seldom weighs more than from 56 to 64 lbs. Its price is low, not only because its intrinsic value is inferior to that of large barley, but also because brewers are more accustomed to the latter, and prefer it. Small barley cannot be mixed with the large and used for making beer, because they do not both germinate at the same time; therefore it is in little request, and at present is hardly used for anything but feeding horses. Its straw appears, even in weight, to be less abundant than that of any other grain.

Two-rowed, long-eared, or large flat Barley.

Many farmers consider that this kind only thrives on clayey soils, but I have often cultivated it on land containing more than sixty-two parts in a hundred of sand, and usually with greater success than small barley, provided that I got it into the ground about the end of March or the beginning of April, with previously ploughing the land, but contenting myself with burying it by means of an extirpator, in land which had been tilled to a considerable depth and thoroughly impregnated with humus, for a weeded crop. Where these conditions have been carefully observed, I have never known the crops entirely to fail; and the smallest quantity which I have obtained in these cases has been six bushels per acre, and that in the summers of 1809 and 1810, when barley suffered so much from drought, especially about the period of the formation of the ear. I have occasionally obtained as much as fifteen bushels per acre from a soil thus tilled and prepared; but then it was in excellent condition, and the season was highly favourable to it. Consequently, I decidedly prefer large to small barley in any rotation which is adapted to this grain.

Large barley, when sown early, suffers but little from frost; and even when the tips of the leaves turn yellow, it has not sustained any great injury. When sown on a sandy soil, the leaves will often assume a yellow tinge during dry weather, but the plants are not the worse; all that is required is a little moisture at the period when the ears are beginning to form, this being the most critical period. But if the plants turn yellow from excess of moisture, which is too often the case in low, damp situations, they will inevitably perish.

In large agricultural undertakings, where it has been sown pretty early, one thing attending it is very inconvenient, namely, that it ripens about the same time as the rye; and although it is less apt to shed its grain than small barley, the labourers must be taken off the rye in order immediately to cut it. This circumstance may be an inducement to sow it later in the spring, and on clayey soils, even as late as the beginning of May; and to sow small barley on the sandy soils. When large barley is ripe a bushel of it will weigh 70 and odd pounds.

Siberian, or quadrangular naked Barley.

Botanists regard this as a variety of the *hordeum vulgare*, or small quadrangular barley, and believe that it always retains a disposition to resume its original form. I have my doubts on this point, although now and then some of the grains strongly resemble those of small barley; these, however, are such as have not attained their full growth, cannot separate themselves from their valves, and either do not germinate and appear above ground at all, or else produce Siberian barley. But as it frequently is almost impossible to distinguish between our cultivated species, we cannot come to any determination on the point.

Siberian is distinguished from small barley by its plants being fuller, more bushy, and putting forth more blades, even when both kinds are grown on the same soil, and the plants sown at equal distances from each other. The stems which bear the ears are much thicker than those of large barley. The ear is longer than that of small barley, and contains a greater number of grains; but the most distinguishing characteristic is, that when the ear ripens, the beard falls off, and the grains separate themselves from the valves, and assume a different form from that of other kinds of barley. Where the soil is rich, the ears of this barley are usually six-rowed.

From its grain being naked, and having an appearance different to that of barley in general, it has been called wheat, rye, barley-wheat, &c.; and also David's corn, Jerusalem corn, and Egyptian or Wallachian corn. Gaspard Bauchin termed this kind of barley *zeopyron* or *tritico speltum.*

As Siberian barley has long been known to both agriculturists and botanists, it seems at first sight strange that it should not be more generally cultivated on fertile soils. Nevertheless, when we come to consider what are the conditions requisite to ensure its success, we cease to wonder that it should not be so. It unites in itself all that can render spring corn recommendable. It is strong; its produce is certain; it grows thickly; the stem which bears the ear is stiff, it yields a considerable quantity of nutritious grain; its straw is excellent, and fully equal to that of wheat straw; and, upon the whole, it is much more productive than large barley. But it requires a fertile, rich, and well-tilled soil; and as my friends have always cultivated it after their fallow crops, I cannot say whether, if sown on the stubble of some other grain, it would yield so much better than all other kinds of barley, which it certainly does in the cases I have named. It must also be got into the ground as early as possible, in order to allow it time to come up, and put forth its leaves and stems before the warmth of the weather induces the formation of the ear. Several persons who have sown it late have seen their crops fail. If attacked by frost while young, it suffers very much. It is said that when sown early, like autumnal corn, it has been cut several times in the course of the summer; and on the succeeding year has yielded a good crop. But this account is, in all probability, exaggerated; at any rate, we cannot give credence to it until it has been confirmed by well attested experiments.

This barley is usually of about the same weight as rye; sometimes a little heavier.

With regard to its nutritious properties, Einhoff found that they amounted to $74\frac{3}{4}$ in a hundred parts, being thus $2\frac{3}{4}$ more than rye. But he observes that it has so large a proportion of sweet mucilage and of vegeto-animal substances, and consequently of the most nutritive matters, that it ought to rank between wheat and rye. ("Annalen des Ackerbaues," b. viii. sec. 27). By adding a little wheat and a little rye to it, a highly nutritious bread may be made.

Several experiments made by brewers with this species of barley have failed, the beer being strong, but thick and muddy; while others, on the contrary, have succeeded in producing very excellent beer.

It is very much prized by brandy distillers. This grain is fully equal in value to rye.

Naked flat Barley.

This kind somewhat resembles the preceding in many respects; but the ears are longer, and it is only two-rowed. When individual plants are cultivated in good garden ground, it yields a larger grain than that of Siberian barley; but decreases in size very materially when a crop is sown in the open field. In all those experiments or trials of it of which I have heard, it yields a much smaller amount of produce than Siberian barley. In speaking thus, I do not, of course, include those experiments made in gardens with a view to ascertain to what extent one grain may be multiplied. This barley is one of the numerous descriptions of grain which I abandoned after having given them a fair trial.

Six-rowed, or Winter Barley.

This is admitted by botanists to be a distinct species, but in my opinion it is only a variety of the quadrangular barley; although, in its natural state, it has a distinguishing characteristic. Quadrangular barley is likewise six-rowed; but in that the grains stand out more when they ripen, and thus form a hexagon. But I believe this to arise solely from some difference in the mode of cultivation, and regard it as more probable that this species has been created by some insensible metamorphosis which has taken place in the *hordeum vulgare;* which ceases to be so delicate when sown early, and may very likely, in the course of several generations, become able to bear the severity of winter, and gradually assume the form of the kind we are now speaking of.

Six-rowed barley, habituated to being sown as autumnal grain, requires a rich yet consistent soil; such a one as would be proper for wheat. In low situations, where the soil is fertile, it is preferred to all other kinds of barley, especially on those lands on which wheat would be liable to be laid; and it is chiefly on this account that it is so much cultivated. It is rarely laid, and sometimes yields an enormous amount of produce—often as much as twenty-eight bushels of grain per acre, and never less than twenty-two. It occasionally suffers from the severity of winter; and where this is the case, it seldom or ever recovers itself. In such cases, therefore, the best way is to break up the ground at once, and sow it with spring barley. On poor, or even on mediocre land, six-rowed barley never thrives; it requires a soil such as would be considered as proper for wheat.

This barley should be sown as early as August, if we would have it capable of resisting the winter, and on a fallow, or some preparatory crop which has thoroughly loosened the soil. Cabbage, or rape is usually considered as the best preparation. It then ripens in good time, either about the end of June or the beginning of July; and this circumstance is a great recommendation to it, as thus the labours of harvest are more divided; besides, at this time barley is often in great request. It is threshed immediately after being reaped, and sent to market. Under these considerations, it offers many very great advantages; but apart from them it finds few advocates, its grain being even more diminutive than that of small barley, and in general lighter, and it being altogether an inferior crop.

Sprat, Battledore, or Rice Barley.

This species is also known by the names of bearded barley, peacock barley, German rice, fan barley, Venetian barley, and Japanese barley. It has long been known, and was formerly much more cultivated in Germany than it now is.

Its ears are shaped like a lancet; they have two rows of strong beards or awns, which diverge from the stem to which the grains are attached.

It grows very bushy, and, consequently, ought to be evenly sown, and treated in all respects like large flat barley.

I have made various trials of it, but cannot discover that it is in any way superior to large barley, excepting that its stem, being short and strong, it is never laid, even when sown on the richest land. But I prefer sowing Siberian barley on good land. I cannot say that I have ever perceived in what manner its grain can be said to resemble rice.

OATS (AVENA SATIVA).

Under this botanical term is comprehended a portion of those varieties of this kind of grain which we know and cultivate. To this species belong :—

1. *The common white or March oat,* which is most generally cultivated, and most to be depended upon when sown in a soil adapted to it.

2. *The heavy oat,* called by us the "English oat," and by them termed the "Polish" or "Spanish oat." It is distinguished by its stiff leaves and stems, large panicles, and equally large grains; at least, when grown on a soil suitable to it. When sown in damp, marshy land, the ear becomes even larger; but then the husk thickens, and the grain acquires little or no additional weight. It is said that it may be cultivated as autumnal grain; but I am not aware that this assertion is borne out by any recorded facts.

3. That *oat* distinguished by naturalists as a particular species, under the name of the *avena trisperma,* which sometimes contains three ripe grains in one husk, but which, for all that, does not appear to yield very large amounts of produce.

4. *The early oat,* which may be sown very soon, and ripens early in the year. This species is chiefly valued in mountainous countries, where all other oats would not ripen before September.

To the black grained oats belong:

5. *The black glossy oat,* the grain of which often weighs ten pounds per bushel more than any other kind, and is,

consequently, infinitely more nutritious. It requires a rich soil, and is peculiarly adapted for low situations, while on elevated grounds it is easily laid or blown down by high winds.

6. *The acorn oat*, the grains of which are partly white and partly black, and which is, consequently, both a variety and a mixture of the white and black oat. It has a very hard husk, but a very farinaceous grain.

We have a distinct kind of oats, and one which has, consequently, been regarded by botanists as a peculiar species, in the—

7. *Georgian, Turkey, or Hungarian oat.* It has a long compact panicle, and its grains turn mostly towards one side. When first introduced, it was said to yield a very large amount of produce; but subsequent experience has served to prove that it yields neither more nor less than common oats. It ripens later, and is not so liable to shed its grain; and probably it is on this account that farmers, who sow a great quantity of oats, continue to grow this on some portion of their land. Its great defect is, that it cannot be threshed without difficulty.

8. *The hairy oat.* I shall not venture to decide whether or not this is the *avena strigosa* of botanists, which they state grows wild with us. General experience has, however, proved that common oats will reproduce themselves on a sandy soil, especially in heathy or furzy districts, and become transformed into this variety—not immediately, it must be confessed, but by degrees; and that they will resume their primitive form on being sown in good ground. Does the same effect result from this as is produced by the growth of hair-grass among autumnal corn, viz., that the wild plant being best adapted to the nature of the soil, establishes itself and chokes or destroys whatever grain is sown? Or does one species actually assume the form of another; and is it, therefore, only a variety? This hairy oat has several strong awns which do not fall of: a thick husk, and but little farina. It hardly weighs half as much as common oats; neverthe-

less, on these poor soils it is not without its advantages. When sown on a richer soil, it puts forth strong stems and a large leaf, and is then cultivated as fodder, and mown while green.

9. *The naked oat (avena nuda).* This kind is but little introduced among us; in Scotland it is much cultivated, and made into bread.

The English recognise various other kinds of oats, but they are only varieties obtained by cultivation.

For some time past, oats have been treated among us as one of the worst and poorest of all the cereal tribe, and, consequently, have only been sown on the worst and poorest portions of land. Formerly, the price of this grain was less than half that of rye; but since a greater number of horses have been kept, its price has risen above that which it bears relatively to other grain, in consequence of its being so eminently adapted for the feeding of these animals, and hence its cultivation has become more profitable. Nevertheless, it is seldom grown even now, excepting in places where it is not deemed advisable to sow any other kind of grain.

The soil for oats may be of any kind whatever, provided it be sufficiently but not too dry; this grain has such vigorous organs that they can dissolve and appropriate nutritious particles which would be of no use to any other kind of corn. They even appear capable of dissolving insoluble acid humus. It will grow on the most tenacious, cold, or clayey soils, as well as on poor gravelly land where nothing else will vegetate. It suffers from unfavourable and inclement weather, but recovers itself much sooner than barley when the weather begins to improve. On newly broken-up land, or on marshy ground, it may be cultivated for several consecutive years, and its produce will often go on increasing until the third or fourth year; while a crop of any other grain would exhaust the soil at once, if it is not immediately ameliorated. The reason of this probably is that oats appropriate to their nourishment every particle which the soil will yield, and which would not be dissolved by other plants without the aid of time and tillage. Oats, when cultivated on a fertile soil, are, however, much more profitable.

In the triennial rotation with a fallow, this grain is cultivated as the fourth or sixth crop, and generally in places where barley would be unable to find any nourishment. It would appear that, on strong wheat land, it is always better to cultivate oats than barley. In the Mecklenburg rotations with pasturage, oats come after barley, and constitute the last crop. The Holstein agriculturists have assigned a better situation to it, by sowing it on broken-up grass land which has been in repose; and they adhere to this plan of proceeding even when, in the ensuing winter, they intend to fallow the ground; for, on broken-up turf, or grass land, where the herbage is not decomposed, oats always succeed well, particularly if sown in good time. This kind of grain is also well adapted for being sown on two-year-old clover, from which the farmer wishes to derive all the benefit he can until autumn. When such land is broken up early in the autumn, and sown with oats in the beginning of spring, covered by harrowing, and then harrowed again when the plants are just above the ground—a kind of cultivation which this grain will bear better than any other—a larger amount of produce will usually be obtained than would have been if the clover had been broken up directly after the first cutting, and the ground ploughed three times, and then sown with autumnal corn.

When oats are sown on the stubble of any other grain, the land must be ploughed once, twice, or thrice. Most agriculturists agree that oats sown on thrice-ploughed land succeed best, but it is seldom that they do plough land three times for this grain: this arises either from want of time, or from the crop being thought not worth the trouble. They are also deterred by a fear lest the sowings should not be performed early enough—a point which is seldom of much consequence, unless the climate is particularly cold. Where oats are sown on two ploughings, an abundance of weeds spring up; and where the soil has previously been infested by weeds propagated by their seeds, I have often found those crops of oats which are sown on two ploughings more scanty than those which are sown on one only. But where, on the other hand, the field has been chiefly infested by weeds propagated by their roots, the crop always succeeds decidedly better after several ploughings. Land is seldom manured for oats, although, now and then, it does happen to be so, and this most frequently when the crop is to be succeeded by autumnal corn. Fresh manure agrees with oats very well, and the greater part of such an amelioration will be left in the soil for the next crop.

Oats are usually sown more thickly than any other kind of grain, either because the bushel contains fewer grains, or because oats do not grow so bushy as other kinds of corn, excepting on very rich soils. One-half more seed than would be considered as the proper quantity for any other kind of grain must be sown in this case; and on broken-up grass land, which has only had one ploughing, the quantity had better be doubled, because all the seeds do not come up. There are, however, some places in which they increase the quantity of seed sown on grass-land to an extraordinary extent, in the hope of thus destroying the weeds.

To ensure the success of a crop of oats, it is necessary that the seed should be plump, fresh, and uninjured by fermentation. Oats which have acquired an unpleasant taste or smell while in the sack or store-house, certainly come up from the ground like others; but they produce a weakly plant, which perishes at the flowering season. I accidentally obtained proofs of this during the period that I was studying agriculture. There is no grain besides wheat, in which this evil requires to be guarded against so much as in oats.

The usual period for sowing oats is in April: on broken up pasture land they are sown in the middle of March, if possible; but where the situation is warm, the sowing may bé delayed as late as the commencement of June; and it is when thus sown that oats succeed best, provided that the weather is favourable: this is occasioned as much by the soil having received a better preparation, as it is by the destruction of the weeds being more complete.

Oats do not germinate so easily as barley; nor is the process of germination so uniform, excepting where it takes place under a very favourable temperature. The crop does not come up simultaneously, nor do the plants ripen equally. Many weeds which germinate with oats, as for instance the wild mustard and the wild radish, tend materially to weaken the crop; and should, therefore, be destroyed by harrowing. Oats bear this operation very well, even after the plants have begun to appear above ground, especially when they have been sown in rows, covered by a light ploughing, and the soil then superficially harrowed. When a period of favourable weather has supervened, and the weeds have only put forth their seminal leaves, the operation of harrowing will be productive of very great benefit; but when the third leaves are developed, and the weeds have taken deep root, it does little or no good; for if it were carried to a sufficient depth to ensure the destruction of the weeds, it would inevitably injure the oats; consequently, many persons have endeavoured to delay burying the oats sown on ploughed land, until they have put forth germs of at least an inch and a-half in length, in order that the crop may shoot up rapidly, and free from weeds. This plan has proved successful with many, their oats having come up exceedingly bushy, and free from weeds; but with me it did not succeed at all, my oats seldom appeared above ground, and an immense quantity of weeds choked the soil. The third and last trial which I made of it was attended with rather better success, for the seed did come up; but a period of dry weather succeeded, which prevented it from thriving as it ought to have done.

Great attention must be paid to the ripening of oats; and where they ripen unequally, the cutting must be commenced the moment that the first part is ripe, or the grain will most likely be shed; besides, if the remainder does not come to maturity, and the grain cannot be separated from it by thrashing, it will but serve to increase the value of the straw, and render it more nourishing. Moreover, the grain which ripens first is always most substantial. When oats have been cut before they are completely ripe, they must be allowed to remain in the swaths for a longer period; and some persons believe that they then ripen and increase in weight: the actual fact is, that they will be very liable to decrease and spoil if left too long.

Oat straw is more esteemed for provender than that of any other grain, perhaps because there usually is more grain left attached to it than to any other kind of straw. In many farms this grain is purposely left, and the oats are but slightly thrashed. When used as litter, and thus converted into manure, it is only regarded as beneficial to warm soils.

As oats weigh very light (not more than fifty pounds per bushel) and, according to an analysis made by Einhoff (a superficial one, it must be confessed), do not contain more than sixty parts in a hundred of nutriment, consequently only thirty pounds in a bushel, this grain is not equal to half the value of rye. But I am inclined to think that Einhoff founded this analysis on observations made on bad oats, and that this grain is worth at least half the value of rye. In many countries it fetches a higher price, on account of its being so much esteemed as fodder for horses; while in others which are far better adapted for its cultivation, but where there is less sale for it, its price falls below one-half the price of rye.

MILLET (PANICUM).

Millium femine-luteo of Tournefort, *Paniculum milliaceum* of Linnæus.

This plant undoubtedly belongs to the cereal tribe.

There are two kinds of it cultivated:—The common millet (*panicum miliaceum*), and the German millet (*panicum Italicum* or *Germanicum*). There are several varieties of each of these, which are chiefly distinguished from one another by the colour of their grain. The common millet is preferred as having the largest grain; and the German millet as being least liable to shed its grain, as ripening more quickly, and as not being so much robbed by birds. The cultivation required by both is the same, or nearly so.

Millet requires a warm, rich, sandy, well pulverized soil. It succeeds better when sown after some crop which has been abundantly manured, than it does when sown immediately after an amelioration of undecomposed manure.

A soil must be tilled to a great depth for its reception, and ploughed three times, besides being harrowed, rolled, and thoroughly freed from weeds. Many farmers dig their ground to a great depth previously to sowing it with this plant; but a good ploughing answers the purpose equally well. Millet is in general very successful on newly drained land, provided that it is in good condition, and also land which has been left in repose for several years; in the latter case a single ploughing is sufficient, if the soil is subsequently harrowed, and well-broken up with a roller, before the seed is put into it. When this class of soils are too dry for linseed, there is no more profitable means of employing them than by sowing them with millet.

Millet should be sown in May; about three metzen of seed is the quantity usually used per acre; a harrow is then passed lightly over the soil, and where the ground is dry, a roller must also be used. The seed must be thoroughly ripe, perfect, and free from disease.

As soon as weeds make their appearance among millet which is just shooting above ground, they must be eradicated by weeding. This is absolutely necessary, if we would not endanger the success of the crop; and can only be dispensed with where the land has only lately been drained, and brought into cultivation, and, consequently, has few or no indigenous weeds. It is on this account that millet can seldom be cultivated to any great extent. One weeding is rarely sufficient for it; for, if the soil is at all disposed to produce weeds, it will require a second, if not a third; each one following about a fortnight or three weeks after the other.

The best way is to tear up the weeds with hand rakes constructed for the purpose; this mode of proceeding answers far better than hand-weeding, as by its means not only all the weeds may be eradicated, but the supernumerary plants may be thinned off. The effect of this cultivation on the success and vegetation of the crop is wonderful; after it the millet shoots up so rapidly that the weeds seldom have time to grow again, or, if they do, it is in very small numbers, and they may easily be pulled up.

Great attention is requisite to seize on the exact moment at which the plant attains maturity, especially with common millet, which ripens very unequally, and is very liable to shed its seed. This evil is, however, much less to be feared where the crop has been cultivated, and thinned in the way we have mentioned. Those who only cultivate millet in patches, cut off the spikes as they ripen, and carry them home in sacks; but as this can only be done where this plant is cultivated but little, the reaping must be commenced as soon as the greater part of the plants are ripe, and performed with great care with a sickle.

This plant must not be left on the ground in swaths, because if rain comes on, and it gets wetted, it sheds its grain. It should, on the contrary, be immediately carried to the barns, and there threshed, and freed from all impurities and foreign substances as much as possible. The grain should then be spread in very thin layers over the floor, and stirred about every day with a rake until perfectly dry, otherwise it will become heated and bitter. The straw is tied up, even though moist, and carried into the air to be dried; if not properly dried, it will become mouldy on being stacked. This straw is much esteemed as provender for cattle.

Although when cultivated to any great extent, it is not possible to cut off the ears separately as they ripen, it is worth while to gather all those in this manner which will be required for seed. Grain which ripened thoroughly, and of which proper care has been taken, shoots up evenly, and produces perfect plants, free from disease, and especially from smut, which frequently manifests itself in this grain where proper precautions have not been taken. That portion of millet which is intended for seed should be preserved in some place through which there is a free circulation of air, and where it can become perfectly dry; it should be threshed when wanted. The best way of freeing millet from its husk is by making use of mills somewhat resembling fulling mills, which beat it with sticks or hammers.

Millet is well known to be a very nutritious grain; in most countries it forms an article of food, and in many cases is used instead of rice. Consequently, its price generally bears a relative proportion to that of rice.

Millet is also cultivated as fodder; it is then sown more thickly, and mown as soon as its panicles are developed.

That plant which is designated under the name of marsh millet, belongs to another species or family of vegetables. One variety of it ripens with us during warm summers, and when sown in gardens; it is called Indian millet (*holcus sorgham*). There are several other kinds, but they all require warmer climates; and it is far from probable that any of them will ever be naturalized in our country, therefore I do not consider it necessary to particularize them.

Rice, and all the varieties of that family, are also by no means adapted to our climate, although in many of the records of different agricultural societies accounts of, and instructions respecting, its cultivation are to be found. I question much if it will ever ripen in the North of Germany, unless it be in hot-houses; even in the South of France, several experiments made with a view of introducing it have been unsuccessful. The nearest place where it can be raised is beyond the Alps.

I am well acquainted with one case, in which the parties thought they had sown and raised rice, and it turned out to be Siberian barley.

Lastly, from its nature, maize should be included among the grain tribe; but as its cultivation differs *in toto* from that of those we have already mentioned, and closely resembles that appertaining to weeded crops, we shall defer all account of it until we come to treat of that portion of our subject.

ON THE CULTIVATION OF GRAIN IN ROWS OR WITH THE HORSE-HOE.

This kind of cultivation is equally applied to all other kinds of crops; but as it appears peculiarly adapted to grain, I shall speak of it here.

We find instances of its being known and practised as far back as the 15th century. Joseph Locatelli, a Spaniard, made some experiments in it which drew upon him the attention of the Emperor, and caused him to be summoned to repeat them in the presence of the Monarch. But what appears still more extraordinary is, that it was known in Persia and Hindostan; that the rows were there sown by proper machines, and the plants cultivated during their vegetation with instruments worked by horses or oxen. In England, Jethro Tull is regarded as the inventor of it. In France, Du Hamel, Chateauvieux, and others, introduced and propagated it about the beginning of the 18th century. But Tull's mode of proceeding, according to which very broad spaces are left between the rows, which are repeatedly tilled with a plough during the vegetation of the crop, is nearly out of date, and has given place to another in which the rows are parallel with, and nearer to each other. We shall content ourselves here with speaking of the latter, and refer our readers for details of the former to the 1st and 3rd vols. of our "English Agriculture." Persons who take an interest in the matter will, probably, have already read those dissertations, and will here find some contradictions of what was then stated; but we must beg them to consider, that the statements which are about to be made, are the result of more mature experience, and founded on numerous experiments.

The machines for sowing corn in rows, and the horse-hoes which have been invented in England, are too numerous to admit of their being severally described. Almost all agriculturists agree that Cooke's sowing machine is the best; but it is very complicated, and must be used with great care. In the first part of my "Description of the Agricultural Instruments in most general use," I have given a plate of *Ducket's* machine for sowing corn in rows; and, in the third part of the same work, that of another invented by myself, with proper descriptions. Long experience has convinced me that the latter is so convenient, durable, and easily used, and answers my purpose so well that I could not desire a better; although I can only sow corn, peas, vetches, and lentils with it, and not any of the smaller seeds which Cooke's machine will sow. Neither can I regulate or alter at will the quantity of the seed of each kind of grain which it shall sow; but it always distributes a quantity which is amply sufficient for every case or exigency; and although it is true that occasionally something might be saved out of this, the saving would be so trifling that it is scarcely worth mentioning. It only uses half the quantity of seed in sowing wheat, rye, and oats, which would be required if the broad-cast or hand sowing were put in practice. This machine suits all kinds of land; it can be used on the stiffest clays without receiving any injury, jolt, dislocation, or fracture, and therefore may be trusted even with inexperienced or careless labourers. Its frame also serves for the horse-hoe; all that is required to be done is, to detach the seed-box and substitute for it some implement of the hoe, coulter, or pronged kind, which will best fufill the end in view. There is not the slightest difficulty in using this instrument, but it is impossible to give an intelligible and useful verbal description of the manner in which it is used.

This kind of cultivation may be bestowed on land of every description, from the most tenacious to the most friable, provided that it has previously been properly tilled. Nevertheless, when it has to be applied to clayey soils, the moment must be seized when they have attained that degree of moisture which best befits them for receiving the various kinds of hoe tillage.

When the soil is very sandy in its nature, those marked advantages so often attendant upon horse-hoe tillage must not be expected. Land containing from 30 to 60 parts in a hundred of clay is best adapted for and best repay this kind of cultivation.

A field may be on a declivity, in which case, the share or six-pronged hoe, which forms a portion of this instrument, does not enter equally into the ground. The soil must be rich and well cultivated to enable this operation to be productive of its full advantages. Poor land will be incapable of feeding that vigorous growth of stems and leaves which is induced by the action of the hoe. When the temperature has been favourable, a considerable increase of produce has often been obtained even on poor soils by sowing the corn in rows, but the proportional increase here was nothing to what it would have been on rich land; and, in many cases, the ears which the plants bore had not sufficient nutriment to enable them to form their grain.

The soil must be completely free from those large stones which come up into the layer of vegetable mould, as the share and the prongs of the hoe would inevitably be broken if they came in contact with them. Small stones do not altogether impede the operation of sowing in rows, but they wear out the implements very much; it ought, in fact, to be laid down as a general rule, that this operation should never be introduced until those stones which are capable of doing harm have all been removed.

Another indispensable condition to the success of this mode of cultivation is, that the land shall be entirely free from those weeds which are propagated by their roots, as well as from all others which perpetuate themselves in the soil; and also that it shall be, as far as possible, free from those which are propagated through the medium of their seeds; for, though many of these weeds are destroyed, and others prevented from coming up by the use of the horse-hoe, they are not completely eradicated. Supposing the horse-hoes entirely to destroy those weeds which come up in the spaces between the rows, they cannot touch those which spring up in the rows and among the corn. The weeds impede the passage of the shares or irons of the hoe, and cause them to drag portions of earth along with them; a part of the weeds certainly are torn up, but those which grow in the rows are only rendered more vigorous, and enabled to shed their seed on ground loosened and prepared for its reception by tillage. Hence it results that this kind of cultivation seldom succeeds in cleansing a soil from weeds which is infested with them; but it will keep a field clear which is from the beginning tolerably free from weeds, provided that pains are taken to detect and pull up every one that makes its appearance among the plants in the rows, which will be a comparatively easy task, for but few will be found.

This system of cultivation admits of the possibility of the ordinary rules for alternating the crops being neglected, which no other can do, and of several crops of corn being raised successively, on account of its tendency to keep the soil loose and clear. A field which has been drilled and properly cultivated with a horse-hoe will generally be found to be so thoroughly loosened and pulverized after the first ploughing as to be fit for the reception of seed without any further preparation. Those persons, therefore, are quite wrong who assert that drill-sowing is intimately connected with alternate rotations; on the contrary, it supersedes the necessity of them, and strict adherence to them renders it almost impossible to drill all the crops: this is one of the principal objections alleged against them by Arthur Young and other English agriculturists. If clover is to be sown on barley which succeeds to a weeded crop, this can only be done where the preparatory tillage has been perfectly performed; the seed must be got into the ground as soon as the hoe has been passed over it for the last time, in order that it may come in contact with a layer of fresh earth. This seed falls into the furrows drawn by the feet of the hoe, and when the weather is favourable, comes up in rows, and yields a fine crop; but sad experience testifies that when the weather is unfavourable it is often completely destroyed. Once, a heavy shower came on directly after I had thus sown my clover, which washed all the loosened earth into the furrows, and wedged the seeds down so tightly that the young shoots could not make their way up, and consequently perished. Another time, in 1810, a long period of drought supervening on the sowings prevented the clover from germinating at all, or else dried it up as soon as it began to sprout. Such late sowings in which the seed cannot be brought into contact with the interior of the soil are always prejudicial to the success of the crop; so much so, indeed, that I have resolved never again to drill barley, when it is my intention to sow clover on it. Autumnal corn may be sown in rows on a single ploughing, provided that that operation has been carefully performed, and the soil has settled down sufficiently; but the roots of the clover impede the action of the machine, and prevent the drilling from being so easily accomplished as it otherwise would have been. On the whole, this kind of tillage keeps land very loose and clear, and causes it to yield crops which, even when sown consecutively, are not nearly so inferior to those which, in the alternate rotations, only occur at certain intervals, as successive crops of grain sown by broadcast and not cultivated with the horse-hoe would be. In fact, this system of tillage may be said, in a great measure, to supersede fallows and weeding.

The advantages of drill sowing may be summed up in this, that by its means the grain can always be placed in the ground at the exact depth required by its nature, by the nature of the soil, and the state of the temperature; and, consequently, every healthy seed is sure to germinate.

But this advantage does not, perhaps, surpass the injury resulting from the accumulation of the seed in the rows; hence it becomes evident that it is the hoe tillage which gives to drill sowing such an incontestible advantage over broadcast sowing, an advantage which has been demonstrated by countless comparative experiments. Every one is well aware that a highly beneficial effect is produced on the vegetation of plants by the loosening of that crust which is formed over the surface of the soil. Hitherto, however, it has been chiefly noticed in garden ground, for very few persons have undertaken experiments on a large scale for the purpose of testing it. This practice is especially beneficial when, in the spring, the hard crust which had been forming all the winter is opened and broken, and the soil thus brought into contact with the atmosphere; and it is on this account that hoe tillage is so much more beneficial when applied to autumnal corn, than it is when applied to spring corn, and especially to such as, like quadrangular barley, vegetates in so short a time that the ground cannot harden sufficiently to impede its growth. It is, however, on wheat that its beneficial effects are generally most evident, either on account of the duration of the vegetation of that grain, or else because wheat requires more nutrition than any other kind of grain, and the action of the hoe brings the nutritive particles of the soil within the reach of its roots. Besides, great benefit arises from that accumulation, and heaping of fresh earth round the stems of the plants, which hoe-tillage effects. This tillage is exceedingly beneficial to all plants, but especially to those which, like cereals, put forth roots from their lower joints, and which roots thus find themselves surrounded with fresh earth. It should be bestowed on the crop when the plants are most in want of nourishment, at the period of their active vegetation, and when the ears begin to show themselves.

It has sometimes been observed that cereals which have been carefully cultivated with a horse-hoe remain longer in the ground, and flower and ripen much later than others. This is not, however, always the case, although I have very frequently remarked it; where it does happen, it will always be favourable to the crop, since the plants then grow more bushy, and, late in the season, put forth a larger number of blades at once. When grain is sown in drills, a greater degree of equality will always be observable between the blades and ears, than is ever seen when the crop is sown by broadcast; and those late and abortive ears which are so often found in crops sown in the last named manner are rarely seen. This kind of tillage gives a greater degree of strength to the bottoms of the stems than any other, and that is one reason that grain sown in rows always stands erect in cases where otherwise it would be laid, a circumstance which is alone sufficient to render it highly advantageous.

Many persons, while they acknowledge the beneficial effects of horse-hoe tillage on damp, tenacious soils, fear to apply it to loose, dry, gravelly land, lest it should tend to render it still more arid; but, on attentive examination, this fear will be found groundless. Land which is kept loose on the surface will retain moisture for a much longer period during the summer, than land which is covered with a hard crust, because during the night the former will attract moisture from the atmosphere. Light rains moisten loose ground much more than they do that which is close, because, in the former the moisture can penetrate into the soil, whereas in the latter it remains on the surface, and is quickly evaporated.

For some time past there has been very great difference of opinion with regard to the distance apart which the rows ought to be. Some farmers consider six inches to be the proper distance, others twelve; but at present it is pretty generally admitted that from eight to nine inches is the distance most suitable to all kinds of grain. Where the space between the rows is less than this, it can hardly be perceived that the earth has been hoed up round the stems of the plants, the instrument takes up so little earth; while, on the other hand, a wider space is useless, and only wastes the ground. The best way is, in spring corn, to drill the rows as close together as possible, and in autumnal corn to set them farther apart. In order to effect this, an alteration must be made in the machine used for drilling; mine drills the rows at about eight inches and a half asunder, and I consider that to be a very good distance.

Next to the grain crops, vegetables profit most by being sown in rows; and this system certainly has a very advantageous effect upon them. I have, however, found it attended with some inconvenience as regards peas; when I have sown them in this manner, I have been only able to cultivate them with the hoe while very young, and then the earth could not be heaped round them for fear of smothering them. As they became older, their stalks spread out so on all sides that the horse-hoe could not be brought near them for fear of tearing them. Notwithstanding the utmost vigilance, I have never been able to seize on the proper period for hoeing this crop with advantage. When I sowed my peas further apart, they did not cover the soil sufficiently, and yielded better certainly, but much less straw than when sown by broadcast. I will not, however, pretend to deny that these inconveniences might be obviated at that time, and then it would become exceedingly advantageous to drill and hoe peas.

On the other hand, drill-sowing is peculiarly adapted to lentils; these plants should be sown at the same distance apart as peas; the smaller ones with the barley, and the larger ones with the oat-cylinder. Lentils thus sown usually bear an extraordinary number of pods, and may, without much trouble, be kept free from weeds.

That which is said respecting the expense of this kind of cultivation will be found, by those who are at all acquainted with it, to be entirely without foundation. Even when the increased expenses of the operation are valued at the highest possible sum, and the cost and keeping in order of the machine also taken into account, these sums will be more than defrayed by the saving in the seed. In order to obtain an approximative, and, at the same time, a sufficiently high estimate of these expenses, I will suppose that only two acres of land can be drilled per day, and the same extent hoed. I shall reckon the horse-labour at twelve groschen per day, and the work of the two labourers at the same; consequently a day's work will cost one rix-dollar. The sowing machine is passed over the ground once and the hoe twice; which will make the sowing of ten acres cost three rix-dollars, or that of a hundred acres thirty rix-dollars. If on one hundred acres of land I sow nine metzen of seed on each one instead of eighteen, I shall save nine hundred metzen, or fifty-six bushels and a-half of seed; and if I reckon each bushel to be worth one rix-dollar, in order to have round numbers, I shall save twenty-six rix-dollars and a quarter. In order to be able to sow one hundred acres of autumnal corn in ten days, I shall require a machine with which I can sow and cultivate a similar extent of spring corn; such an one, with all its fittings up, may be obtained for one hundred and fifty rix-dollars. To this sum I shall add 4 per cent. interest, besides a diminution of capital of one-sixth per annum; consequently, in six years there will be one hundred and eighty-six dollars. On the seventh year it will be paid for by the saving it has effected in the seed. Such a machine will certainly last twenty years, especially if only used for autumnal corn. Every three or four years it will require repairs, but the saving in seed will be amply sufficient to cover these, and some left to allow of the hoes being newly ironed or footed if requisite.

Should it be necessary, as some persons pretend that it is, to keep an extra horse solely for the performance of this operation, then drill sowing will undoubtedly become expensive; but there are very few farms in which this will be requisite.

Besides, the advantages arising from drill sowing do not, as some imagine, consist solely in the saving of seed which is thus effected, but in the increased amount of produce which, under this system, the land may be made to bear. The fact of this increase is demonstrated by a thousand experiments, and no doubt can longer be entertained on the subject even by the most virulent opponents of the system. No general estimate as to the average amount of this increase can be given, as most of the comparative experiments made for the purpose of determining it have been attended with different results. In many of them the wheat thus sown yielded one-third more than that which was sown broadcast; this calculation was based on the extent of land sown, and not on the quantity of seed used: according to another experiment it only yielded one-fifth more, and according to another only one-tenth. The variation in these results was, in a great measure, created by the nature and condition of the soil. The richer, deeper, and more free from stones and weeds a soil is, the greater will be the advantages arising from drill-sowing; while on poor, shallow land, the benefits will be but trifling. Many farmers who pursue this system of sowing state that the longer they adhere to it the better their land becomes; while others, on the contrary, assert that the land deteriorates. This contradiction may easily be accounted for; there is little doubt but that the former manured the soil sufficiently to maintain its fertility, whereas the latter neglected to do so, and put their faith entirely in the beneficial effects of horse-hoe tillage; for it cannot be doubted that the soil is exhausted by the additional amount of produce which drill-sowing causes it to bear, although this exhaustion is not apparent during the few first years.

The grain of cereals which are regularly sown in this manner, acquires greater perfection every time it is reproduced. All the experiments which have hitherto been made tend to prove that it is much heavier than that which has been sown broadcast. In flat barley I have found a difference of 6 lbs. per bushel, and in wheat an even greater increase of weight. The grain is large and full, which renders it peculiarly well adapted for seed. If, then, we would obtain good grain for seed, we must always keep a machine for drilling, and use it.

We cannot, however, advise the adoption of drill-sowing for every kind of grain, or even for all winter grain, excepting in those agricultural undertakings in which every detail is carried to the highest degree of perfection, and the whole process of cultivation followed up with science and skill. Crops sown in drills or rows require constant attention to enable the farmer to fix upon the best period and means of hoeing them. One single instance of carelessness or neglect will often seriously injure the crop; therefore, those who are not well skilled in all the manipulations of this system must proceed with the utmost circumspection, and experimentalize on a small piece of ground first, in order to learn how to manage: most persons, when first they begin to use the horse-hoe, are either too timid or too venturesome. Drill-sowing when applied to poor land does not repay the labour and trouble it occasions. Lastly, in a farm which is not properly organized, and where there must necessarily be many things which require the attention of the farmer, it is seldom prudent to enter upon this system of cultivation.

It is in the spring only that autumnal corn should be hoed: when this cultivation is applied to the crops in the autumn, it does not appear to be productive of any great benefit, let the seed have been got into the ground ever so early. The crop should be hoed as soon as the seed begins to appear, and the ground is tolerably dry. In general it will be found advantageous to pass an iron harrow across the rows first, which serves to break that hard crust which has been formed over the surface of the soil during winter; where this is not done, the feet of the hoe will be very likely to throw the earth over the young plants, and smother them. Should the soil be too tenacious to break at once, a roller must be passed over it after the harrow, provided that the ground is dry enough to admit of this operation being performed, for it is of the utmost importance that the surface should be thoroughly pulverized. The next step to be taken is to fit such irons on to the horse-hoe as will drive the soil from the middle of the spaces, and heap it against the rows of plants on either side: this should be done at the period when the corn is beginning to shoot up, and put forth its stems and blades. Such cultivation will not do the crop any harm, even if adopted after the plants have put forth their leaves and stems; but it should be finished before the ears begin to form. The farmer must endeavour to embrace that moment for the performance of this operation when the soil contains exactly the proper amount of moisture, and is neither too much hardened by drought, or softened and rendered clammy by wet. It will not unfrequently happen, when the weather is unfavourable, that he will be obliged to select the spots where it will be best to commence. This is, in fact, the most critical period for drilled crops; nevertheless, where skill and activity are employed, there is little fear of any want of success. There doubtless are now and then cases in which the weather is so unfavourable that the hoeing cannot be accomplished: when such occur, no very luxuriant crop can be anticipated; but if the first parts of the operation have been properly performed, corn sown in rows will always yield a larger amount of produce than that which has been sown broadcast.

Many farmers only hoe spring corn once, and then have such irons attached to the instrument as will heap the earth round the roots of the plants; and they apply this cultivation to the crop at the period when the plants are just putting forth their blades: but the crop always thrives best when it has been cultivated with rake-like irons while very young; and such cultivation is the more advantageous when it clears away the weeds from between the rows. It must not, however, be performed so soon as to cause the tops of the plants to be covered with earth. Rakes which are intended to be passed over the land early in the season must be flat and not convex, in order that the earth may slide over them, and not be thrown to the sides.

Some agriculturists have preferred dibbling corn to sowing it in rows. Where such a plan is carried into effect, the plants not only come up in regular rows, but are at equal distances from each other in those rows, and may then be cultivated in every direction, either with instruments, or by hand. A still greater saving of seed is thus effected, and one quarter of the amount usually employed will be found sufficient. When grain is dear, this saving will almost defray the expense of the labour; and hence it is that in years of scarcity this practice has found so many advocates. The seed is put into the ground by means of a dibble, having holes in it three or four inches apart, in each of which a few grains are placed; or, with what is still better, an instrument made on purpose, and similar to that used by gardeners for sowing peas: by means of pressure of the foot, this instrument makes twelve holes at a time. The furrows drawn by the plough serve to give a direction to the rows, and a line is drawn down the centre of each of these; the ground is subsequently harrowed.

It must be evident to every one that this mode of proceeding occupies a very considerable amount of time, and, consequently, can only be applicable under certain circumstances, and to a limited extent. The small farmer who works himself, and is chiefly assisted by his own family, will be most likely to derive benefit from it. Many attempts have been made to invent instruments or machines which will perform the office of dibblers, and sow the grain at uniform distances; but it has been found impossible to carry out the plan. Various experiments have also been made on this subject in Paris, which are related at some length by the Comte François de Neufchateau, in a work entitled "L'Art de Multiplier les Grains." Paris, 1809. But this work treats only of the multiplication of the seed, and scarcely refers to the expense or extent of the sowings.

LEGUMINOUS CROPS.

The cultivation of leguminous plants or of siliquous crops (for hitherto no distinction has been made in agricultural phraseology between these two kinds of produce), is, doubtless, quite as ancient as that of cereals; for reason and experience have combined to teach mankind that it is impossible to cultivate anything more nourishing, better adapted to the animal frame, and, at the same time, which yields so plentiful a crop.

Leguminous plants contain a large quantity of what

Einhoff calls "*vegeto-animal*" matter (*thierische vegetabilische substanz*). This substance bears a very great affinity to animal matter, and is quite as nutritious as gluten, as it constitutes the predominating ingredient in vegetables, and they are more nourishing than cereals. It has long been known that lentils, peas, and beans, not only satisfy hunger best, but are more easy of digestion, and have a greater tendency to strengthen the frame than any other vegetable products. To the healthy labourer they supply the place of animal food, and yield that nutriment of which rye and potatoes are incapable. With us, they are absolute necessaries to those who work hard, and especially to sailors; neither landsmen nor sailors are contented unless they can have a meal of legumes at least twice a week. Both experience and chemical analysis tend to prove that legumes are the most nourishing part of the vegetable kingdom. The straw, even when exhausted, is equal to the straw of grain; but as it never is dry when mown, especially that derived from climbing vegetables, which retains its succulency and vitality unimpaired up to the period of its being cut, it is generally much more nourishing than the straw of grain crops. The haulm of these vegetables, too, when cut before the formation of the fruit or seed, yields a far more nourishing fodder than any of the cereals do.

This class of leguminous plants appear not only to be particularly nourishing to men and animals, but even to supply food to vegetables. The great proportion of vegeto-animal matter which they contain, causes them in a great measure to resemble animal manure, to be very easily decomposed by putrefaction, and to enter more promptly into the composition of plants. It is on this account that from time immemorial, they have been used in Europe for the amelioration of other crops. The lupine, which on account of its bitterness cannot be otherwise employed, is the chief one of this tribe which is ploughed into the ground as green manure; not only is this plant buried while green, but its seed is made use of for the purpose of dressing olive trees, after having been steeped in boiling water, in order to destroy its germinating principle. Other vegetables are likewise similarly employed.

Besides this vegeto-animal substance, leguminous plants contain starch, and a soluble mucous matter, similar to that contained in the grain of cereals, but not so sweet.

The best way of preparing vegetables for food, is to boil them. Their various component parts are thus brought into more intimate combination, and rendered more soluble, digestible, and agreeable to the stomach. They gain as much by this mode of proceeding as grain does by fermentation, and by being made into bread. They may themselves be made into bread, but then it has a crude, unpleasant, rancid taste. They are not unfrequently mixed with rye, or wheat flour, and then they render the bread more nourishing without altering its flavour.

There cannot be a doubt but that products which contain so much nutritive matter must deprive the soil on which they grow of a corresponding portion of its nutrition. Nevertheless, it appears that these plants derive a far greater portion of their nourishment from the atmosphere and from water than cereals do, and that they adapt it to their use by means of their organs. I cannot go so far as to affirm, with some persons, that vegetables derive from the soil, appropriate, and apply to their nourishment a peculiar substance, which is rejected by all kinds of cereals; but certain it is that the proportional quantity in which they absorb the primitive substances is different. General experience teaches us to regard these substances as fallow crops, or crops which ameliorate the soil, and the alternate cultivation of which and of grain crops tends to maintain it in good condition, and ensure far more luxuriant corn crops than could be obtained if grain were always cultivated. It would be superfluous to add anything to what we have already said in the first volume of this work respecting the necessity of a rotation of crops, for every experienced agriculturist well knows that even good manuring will not maintain land in condition on which consecutive crops of grain alone are cultivated, and that an alternation of vegetable crops with these is absolutely necessary.

THE PEA.

The pea is the kind of pulse most generally cultivated among us.

There are two principal varieties: the yellow, which is chiefly used in this country; and the grey, or Prussian pea, which is chiefly cultivated in Prussia and Poland.

The yellow pea furnishes us with another variety, which, even when dry, preserves its green hue, but is not otherwise distinguished.

Gardeners raise new varieties of this vegetable every year; but their characters are not permanent, and they speedily degenerate unless cultivated with great care. There are some kinds in which the pods form and ripen early, and the haulm is not so strong as in others. These are looked upon as a more certain crop, the husk of the pea is thought to be finer, and the pea itself more tender; but the larger and later variety often yields the greatest amount of produce, both as regards peas and haulm. That, however, to which, in the majority of cases, preference should be given, is the early variety; it not being so liable to be attacked by mildew before the pods are formed, and from being ready to be gathered early, leaving more time for the preparation of the soil and the sowing of the crop which is to succeed to it.

The grey Prussian pea, which is large and angular in shape, and bears a violet coloured flower, is said not to bear change of climate, and to degenerate. In Line and Weser, a grey pea, bearing violet coloured flowers, is cultivated; but it is grown almost exclusively as fodder for cattle, and considered to be unfit for the use of man on account of its unpleasant taste. This is probably a variety of the Prussian pea.

The yellow pea, for the most part, bears white flowers; some, however, bear violet coloured flowers speckled with black. Many persons are of opinion that this has been occasioned by some cross with vetches; but from what I have observed, such cannot be the case, and the alteration of the colour of the flower arises from something in the soil or temperature not hitherto discovered.

A clayey, sandy, or calcareous soil, which is not too much exposed either to cold, wet, or drought, is doubtless the best for peas; this pulse will, however, succeed on stiff as well as on sandy clays, when the latter are not too dry, and the weather is favourable. But in all situations calcareous particles seem to be favourable to its vegetation, even when they only exist in small, or even minute portions. In many countries peas have only been found to succeed on such soils as had been ameliorated with lime or marl, and the effect has been perceptible even where a considerable period had elapsed since the manuring of the soil. On the other hand, they do not appear to be able to bear the slightest degree of acidity in the soil; and hence the beneficial effects of lime and marl on this kind of crop, may arise chiefly from the tendency of those substances to destroy all acidity.

In the triennial rotation, peas are cultivated on the fallow; this usage is established in almost every place where the soil is adapted for the production of peas. It cannot, however, be denied that after peas the crop of autumnal corn is not usually so luxuriant as it would have been after a fallow; and the soil is more infested with weeds, especially if peas have frequently been sown on that place, instead of a summer fallow and ploughing being given. This circumstance causes many persons to be found who are so attached to the old plan that they will sow their peas on the division intended for spring corn, rather than on a fallow; and then cause the peas to be succeeded by a dead fallow, in order to be able to point out the luxuriance of their crops of autumnal corn to the partisans of fallow crops. These adherents of the old system have even gone so far as to attribute the pretended scarcity of corn, and its dearness for some years past, to the custom of sowing peas on the fallows. But, provided that the peas do not come too often, and the tillage of the fallows is not altogether neglected, and the soil is properly tilled both before and after the pea crop, there is no danger to be apprehended; and the slight diminution which is visible in the produce of the autumnal corn will be doubly and trebly compensated by the produce of the peas, while the impoverishment which they may occasion will be amply atoned for by the amelioration arising from their haulm.

In alternate rotations with pasturage, peas have long been placed after all the other crops, and cultivated on the last division, or that which precedes the repose, and have in general succeeded but badly; but a better system is now pretty generally coming into practice.* It is an undoubted fact, that peas succeed remarkably well on the stubble of clover, and after any weeded crop—as potatoes, for example. But both of these also form an excellent preparation for corn; consequently, between them and the peas a crop of wheat is usually taken. Some persons are of opinion that peas never succeed well on land where they have not been sown before, and, consequently, always sow them in the same places. This, however, is mere prejudice, unless there are other causes which render the rest of the fields unfit for the production of peas. Others, on the contrary, fear lest the peas should degenerate, if they or any similar leguminous crop are sown too frequently on the same spot; but there is nothing in experience which tends to confirm this, and all fear of evil may be avoided by manuring the land between the two, and bestowing proper tillage upon it.

There are various opinions as to whether peas ought to be cultivated as a first, second, or third crop after the soil has been manured. Many farmers fear that, by sowing them immediately after an amelioration of manure, they shall only obtain an abundance which will grow and flower without bearing any pods or yielding any seed.

* See "Das gerechte Verhaeltniss, der Viehzucht und des Ackerbaues." S. 146; "Annalen der Mecklenburgischen Landwirthschaftsgesellschafts." B. 11; S. 276.

Those whose land is so rich as on average years to lead them to apprehend this evil, will do well to abstain from manuring for peas. But such is by no means a usual case; and even though the produce of the grain crop should be slightly diminished, it is desirable that the peas should vegetate luxuriantly, on account of the great utility of the haulm, and the fertilizing influence which its shadow exercises on the soil when the crop is thick and vigorous.

On land of an average quality, peas which have been manured are always infinitely superior in point of quantity as well as haulm to any others, and they then leave the soil in a condition peculiarly favourable to the succeeding crop; for it is well known that a scanty crop of this vegetable leaves the soil infested with weeds. It is, however, seldom advisable to manure very plentifully for peas.

Every year fresh comparative experiments have furnished us with additional proofs that manure, whether decomposed or fresh and strawy, when spread over the soil after the sowing, is not only more advantageous to peas sown on sandy clays than it would have been if buried by a ploughing, but that it is also more beneficial to the grain crop which is to succeed the peas. Experience has demonstrated in a striking manner that all those theoretic principles which appear to contradict this fact, fall before it. I cannot, however, extend this practice to stiff, clayey soils; for I am not aware that any experiments have been made, for the purpose of testing its efficacy on land of that description.

Another mode of proceeding is to bury the manure with the peas, and for this purpose the peas are sown broadcast on the manure after it has been spread.

It has been observed, those crops of peas which have been manured with the dung of sheep or horses are always finer flavoured and have a thinner husk than of such as have been sown on the manure produced by cattle and pigs. Ameliorations of lime and ashes are productive of similar advantages.

Although it is universally admitted that peas thrive best on a loose, well pulverized soil, nevertheless, many agriculturists have become convinced by experience, that when sown on one ploughing, they succeed better than after the most elaborate tillage. I do not intend to deny the truth of the experiments adduced in support of this; but what I say is, that there were, undoubtedly, some particular circumstances which influenced the result, and I cannot receive these statements as any foundation for a general rule. Where a damp soil has been broken up before the commencement of winter, the upper layer of earth is very likely to become so saturated with water, as in the spring to render it impossible to plough it for the reception of seed, without turning it into clods instead of dividing it. The farmer does not wish to depart from that rule which prescribes that the seed shall be sown as early as possible, and, consequently, throws the peas into a soil which the plough has hardened instead of loosened, and which is by no means adapted for the reception of this kind of pulse. On land which is not subject to this inconvenience, and where the farmer need not begin to plough the ground which was broken up before the commencement of winter, until it is sufficiently dry to benefit by that operation, a crop sown on two ploughings is always finer and better; and though a great quantity of weeds come up, the peas always get the upper hand. The practice of drilling peas is decidedly more advantageous than any other on dry land.

It is usually advisable to sow peas as early in the year as possible; in fact, they are the first crop which should be got into the ground in the spring. Frosts do not injure them, even when they have begun to come up. I have not, however, found it injurious to peas to sow them late in the spring; on the contrary, I must confess that those which I have sown in May have always succeeded best, at least, so far as regards the produce in haulm. I do not, however, make it a rule to sow them late, because the success of the crops I have just mentioned always appeared to me to be chiefly owing to the state of the weather. Peas which are sown early in the season, we are told, escape the attacks of mildew previous to the formation of the pods, and, consequently, their grain is but little injured, although the vegetation of the plant is arrested. But I have invariably observed, that this disease does not attack the late peas which are in full vigour, while it destroys the early ones. Eckardt advises that the peas should not all be sown at once, but a period of nine or fifteen days suffered to elapse between each sowing, by which means the whole crop will be prevented from failing. I cordially agree with him in this opinion, and, at the same time, make it a rule never to sow while the ground is very damp, or when the furrow-slice hardens instead of dividing on being turned over by the mould-board. The quantity of seed usually sown for peas is from a bushel to twenty metzen per acre. It is calculated that when a bushel is sown twelve grains fall on every square foot, which would be too much if spread uniformly over the surface. When peas are sown on furrows, a certain portion cannot be prevented from remaining uncovered, and becoming a prey to birds, which are so greedy after this grain, that they will even dig it up after it has been buried. When peas are sown under furrows, this evil is not so much felt, although even then it cannot be altogether prevented, and the peas germinate much sooner. This, of course, makes a difference in the quantity of seed which it is necessary to sow. It has also been observed, that when a great deal of rain falls during the flowering season, those peas which are not too crowded set, or pass from flower into fruit, and bear much better than those in close thick-set crops; while these latter yield most haulm, and leave the soil in a better condition. It is, therefore, requisite to ascertain with what view the peas are sown, before we venture to determine whether it is most beneficial to sow thickly or not. Some agriculturists pretend that they destroy the weeds by sowing their peas as thickly as possible, and, therefore, use two bushels of seed per acre; but I do not believe that they attain the end in view by this means, for the weeds, and especially the wild mustard, spring up and vegetate much more quickly than the peas, unless a very favourable season accelerates the growth of the latter.

Some agriculturists have strongly advised that peas should not be harrowed after they have begun to come up; while others, and especially Dullo, in his excellent treatise upon agriculture, have as strongly recommended this practice as a means of destroying those weeds which are then appearing above ground, and only stipulate that the operation shall not be performed until the plants begin to put forth their leaves. In those experiments which I have made relative to this point, I have never been able to discover that the plants were at all injured by the harrowing; neither could I discover that it had much effect on the weeds, for they were too deeply rooted in the soil. Perhaps the best mode of proceeding is not to harrow at all after the peas have been sown under furrows, until they begin to come up and develop their leaves, and then the passing of the instrument over the rough ploughed land will, perhaps, succeed better in destroying the weeds. But I have not as yet put this plan into practice. Dullo, in his work which I have before alluded to, states that he has ploughed peas into the ground, with great success, eight or ten days after they were sown, and consequently after they had begun to germinate; and that these peas came up well, and were peculiarly free from weeds.

In England, peas are frequently cultivated with the hand-hoe; and those which have been sown broadcast, are thinned. Small farmers frequently weed these crops. It would be impossible for us to bestow all this care on them, for we usually sow peas on immense extents of land.

When the wild mustard and radish have shot up so fast as almost to stifle the peas, and are in full vegetation, I have, in common with other agriculturists, had them mown; but the tops of the peas cannot be prevented from also suffering from this proceeding. When, however, the soil is rich and the weather favourable, the crop is rather benefited than injured by it; but under opposite circumstances the peas suffer greatly, and the weeds again get the upper hand.

Weather and temperature have a greater influence on the success of peas and on their formation than on almost any other field crop; hence it is scarcely possible to calculate the average produce which a crop will yield. Damp weather during the flowering season is rather beneficial than injurious, because the conformation of the flower protects it from the introduction of moisture. In dry weather the flower very frequently dries up without setting.

It is very unfortunate if at the flowering season the crop is attacked by mildew; where such is the case, a very promising crop will in four-and-twenty hours often be completely destroyed, and all the flowers will fall without setting. Occasionally there appears to be some matter in the air which acts on the plants in a manner as yet unknown to us, and prevents the formation of the grain; this is frequently observable in buckwheat, as well as in other crops.

Some persons stick field peas as they would garden peas. This mode of proceeding certainly prevents the crop from being laid, and facilitates the formation of the seed, but it greatly increases the amount of labour required.

In a few places, the farmers are in the habit of covering a field sown with peas with a layer of straw, and then leaving the peas to make their way through it, and then vegetate; by this means the weeds are all stifled, the soil kept moist, and those stems which fall to the ground prevented from rotting. Where there is a plentiful supply or straw, this may be done with advantage, and the straw will afterwards be available as manure.

It is necessary to embrace the exact period at which the peas are ready to be cut without loss of time. In general, the best way is to be guided by the maturity of the early pods, without noticing the later ones, otherwise the largest and best part of the crop is liable to be lost. The only exception to this rule occurs when the state of the temperature has been such as only to admit of a few of the first flowers setting, while the later ones, having encountered more favourable weather, have been more successful. But such cases rarely occur; it much oftener happens that the peas are still green and in flower at the top, while the lower pods are ripe and dry. The farmer must not, on any account, wait for the later flowers to come to maturity, for the plants will continue to flower until all the inferior pods have shed their seed. These late flowers are by no means injurious, if they do not mislead the farmer and prevent him from mowing at the proper season. The straw is then better and more nourishing, and those peas which have not ripened may be made useful in various ways. The only thing which is difficult, is to dry the haulm thoroughly.

When the peas are laid, it is very difficult to mow them. The sickle is the best instrument that can be employed for this purpose.

When the weather is unfavourable, it is very difficult to dry the haulm. During alternate rains and sunshine the pods open, almost the whole of the grain is shed on the field, and nothing is left to be carried but the haulm or straw; this is particularly the case when peas are left in the wads or wisps, and frequently turned with the intention of drying them. When weather of this kind comes on, I have always found it best to cock the peas as soon as ever they began to fade; and if the rain continued, to content myself with raising them a little with the handle of a rake, and to leave them in the same place until they were sufficiently dry to be carried. It cannot be denied that the straw loses some of its goodness under this mode of proceeding; but then there is less harm to be feared in other respects, and the peas are prevented from shedding their seed and leaves. When the weather is fine, it will be found most advantageous to leave the peas in the wads or wisps to dry; and, if necessary, to do so with the hand and not with a rake.

As it is of the utmost importance to the succeeding crop that the land should be ploughed as soon as possible after the peas have been mown, it is best to lay these latter on as narrow strips of earth as possible, in order that, if the getting in of the crop is delayed, the intervening spaces may be ploughed without loss of time. However tiresome this mode of proceeding may appear to be, every agriculturist who is aware of the importance of breaking up the pea stubble with as little delay as possible will not neglect this precaution.

Some persons tie the peas before carrying them, but this is a very useless trouble.

The produce of the pea in ripened seeds is so casual that it is almost impossible to lay down any general average with regard to its amount. From some fields I obtained thirteen and a-half bushels of seed one year, and only two and a-half bushels on another, although both times the same routine of cultivation was pursued. On good soils, from five to six bushels may be regarded as an approximative average of the produce per acre.

The price of peas is as variable as their produce. Sometimes it is equal to that of rye; at others, much higher. Provided that the peas are not attacked by worms after being brought into the granary, they may be kept in casks for a considerable period; and, indeed, it is as well to preserve them, as there will always be a supply in hand to meet the exigencies of any year in which this kind of crop fails.

I cannot either state what is the general average between the proportion of grain and of straw, for sometimes the amount of one, and sometimes that of the other predominates. When the soil is good, and has been well manured, we may, however, always reckon with tolerable certainty upon a good crop of straw if not of seed, and, as in most farms straw is of the greatest importance, and chiefly prized, the agriculturists cultivate peas with a view of obtaining it, and receive a good crop of grain as an additional blessing. A good, well-tilled field sown with peas will yield from twelve to sixteen quintals of haulm per acre, unless a period of dry weather impedes the vegetation before the time when it naturally would stop; under peculiarly favourable circumstances, even more than this may be obtained.

Pea-haulm is considered to be peculiarly adapted for sheep; many farmers give it instead of hay, but this can only be done when the greater part of the haulm was green at the time of its being mown. In general it is more bulky and nourishing than the straw of any of the cereal grasses. Pea-haulm is also given to horses and cattle; but for them it must be chopped, because the stems are usually too tough to admit of their being easily masticated, and they are apt to slip between the teeth. The refuse which is left after the peas have been threshed is likewise very nutritious. It is always best to consume the pea-haulm before any other kind, and not to keep it until the spring.

THE LENTIL.

There are two varieties of the common lentil; one small and of a brownish hue, and the other large and more inclined to yellow. The small variety has an aromatic flavour which is peculiar to it, and this causes it to be preferred by many persons; the other, however, finds the readiest sale. These two varieties are very frequently crossed, and thus a mixed lentil is produced which is the one most commonly grown. The quality of the soil has a considerable influence upon the size of the seed.

Latterly the Provence lentil, which is almost as large and of the same colour as the pea, has been recommended. It yields a larger produce than the others, both in straw and grain, even when sown on sandy soils, but has very little of the flavour of a lentil, and more resembles the taste of a pea, which causes it to be much sought for as a dish for the table. As it grows very tall, it answers almost as well on sandy soils as vetches; and I consider it as a better product, whether cultivated as fodder or for the sake of its grain.

Lentils require a soil containing a tolerable proportion of sand, and which is in good condition. They seldom thrive on clayey soils.

This crop is sown later than peas on account of its suffering more from cold. Twelve metzen of seed per acre will be found sufficient; but care must be taken that this seed is pure and not intermingled with the seed of vetches, or the sale of the lentils will be injured. As the haulm of lentils is delicate and feeble, the plants are very liable to be choked by weeds, unless the ground is kept carefully weeded. Many persons dibble lentils in rows, leaving room for a rake to pass between; for my own part, I can see no reason why this crop should not be sown with a drilling machine, and afterwards cultivated with a horse-hoe.

The lentil contains a greater proportion of vegeto-animal matter than any other vegetable, and is universally regarded as being highly nutritious. From the time of Esau up to the present day it has been considered as an article of food. This vegetable fetches a higher price than peas; and as, when grown on a soil which has been properly tilled and is adapted for their reception, they yield from eight to ten bushels per acre, their culture is very lucrative. They do not yield much straw; but what there is, is very delicate and nourishing, and somewhat similar to the best hay; consequently, it is usually reserved for young animals, as lambs and calves. As lentils require to be kept very free from weeds, the culture of this crop tends to improve and clear the soil.

KIDNEY-BEANS, HARICOTS.

A great number of varieties are cultivated in gardens, the pods of which are generally gathered while green. Dwarf species are cultivated in the fields. As these require all the attention of garden cultivation, and must be carefully trained and weeded, they may be said to be unfit for field crops, and can only be cultivated, to any extent, by means of implements adapted for the purpose.* It is on this account that we merely allude to them here, reserving what further appertains to the subject until we come to treat of the cultivation of maize, with which that of haricots may be advantageously associated.

BEANS (VICIA FABIA).

Numerous varieties of the *vicia fabia* are cultivated both in fields and gardens, but the small round variety which bears so many pods, and is known by the name of the horse-bean, is most common. It varies in colour, verging sometimes on yellow, at others being of a dark-brown hue, and at others spotted with various shades; but this difference of colour is not permanent, and has no influence on the other properties of the bean.

The bean requires a rich, strong, loamy soil, similar in quality to wheat land; it may, however, be cultivated with advantage on lands which are not quite so strong, provided that they are tolerably moist, and contain a large quantity of humus, and that humus is not of too acid a nature; for I have found that beans are subject to rust. Beans serve to loosen stiff soils; the filaments of their roots will penetrate even the hardest clay. Hence they have been regarded as an excellent preparation for wheat on land of this description. Their roots and the shadow of their leaves and haulm serve to keep the soil loose and clear.

When the soil appears to require amelioration, it must be manured for this crop, and that somewhat plentifully; for beans require a good soil, and will bear a considerable quantity of manure. This plant will make its way through the most tenacious soils, and therefore may be

* Those kinds of haricots which do not grow very tall, never require sticking; and, as their stem is stronger than that of peas, they may be the more easily cultivated with the horse-hoe during the early periods of their vegetation. These dwarf varieties are, therefore, well-adapted for being sown and raised in open fields, and on all farms or agricultural undertakings where an improved system of agriculture is pursued.—French Trans.

buried with the manure, and by the first ploughing. It has even been attempted, and not without success, to sow beans on a tenacious and compact turf, and plough them in; and they have invariably been found to make their way through. There is not, however, any doubt but that they are benefited by a second ploughing; and the reason why this is not more frequently bestowed is, that most persons consider it to be absolutely necessary to get the seed into the ground as early as possible; and, therefore, clayey soils which have been ploughed up in the autumn do not dry soon enough in the spring to admit of their being ploughed before the seed is got into the ground.

It is generally believed that those beans which are sown earliest thrive best; and consequently, when the weather will admit of it, they are sown in December; for most persons are of opinion that, even though they may suffer from frost, and their leaves become yellow and wither, other leaves will replace these, and, on the whole, the plants will not suffer. I cannot exactly coincide with this opinion, since it has always appeared to me that the beans which have been sown the latest thrive the best.

As the grain is very large, a considerable quantity of seed is often required—often as much as from two to three bushels per acre. English agriculturists say that on strong land which is moist, beans should be sown far apart; and on light dry soils near together, in order that in the latter case they may overshadow the whole of the land. The plants do not bear so many pods when sown closely, as they do when sown far apart.

Beans are everywhere cultivated as a preparatory crop, or instead of the fallow crop. Sometimes a meadow which is newly-broken up is devoted to them, or they are sown as the first crop on land which has been left in repose or laid down for pasturage, and which is afterwards to be sown with grain.

When beans have been buried with the plough, the harrow must only be passed very lightly over the ground;

but as soon as they begin to come up and put forth their leaves, they should be well harrowed. Beans will bear a pretty good harrowing with an iron-toothed harrow; for even those which are broken off or torn by this operation will shoot afresh.

While young, they require to be kept perfectly free from weeds; and where this cannot be effected by harrowing, the crop should be hoed if we would have it succeed. In some places, recourse is had to the singular proceeding of turning the sheep on to the bean fields when the plants are about two inches above the ground. These animals will not touch the beans so long as they can find a single morsel of anything else to eat.

The practice of sowing beans in rows is adopted even in places where the proper machines for accomplishing this operation and horse-hoes are unknown. Where they have no drill-machines, the beans are sown by hand in every third or fourth furrow drawn by the plough, and about two bushels of seed per acre is used. When the beans have begun to come up, a plough is passed along each side of every line, in order to throw the earth off the plants; and in a short time afterwards this implement is again used in an opposite manner to heap the earth round the plants. A plough or a binoir is best adapted for the performance of this operation; I have, however, seen it very well accomplished with a common wheel-plough. The rows are sometimes as much as three feet or more apart. But the plants are sown very close to one another in the rows. There cannot be a doubt but that the crops can be sown in this manner much better with the proper implements, and that less seed will then be required; twenty metzen per acre will be found to be amply sufficient.

Beans which have been drilled, and subsequently cultivated with the horse-hoe, yield a much larger produce in grain than those which have been sown by broadcast; on an average, the former may be said to yield twice as much as the latter. They bear pods even down to the very bottom of their stems, while those which are sown too closely never do. It is not unusual to find from thirty to forty pods on each plant sown by a drilling-machine, while those sown in the other way rarely bear more than ten. As the lower flowers set early, they escape the attacks both of rust and mildew, which diseases often prevent the later flowers from bearing pods or seed. But the haulm of beans sown in rows is decidedly inferior to that of those sown broadcast; the lower part of the stems becomes hard and ligneous, and the leaves are more apt to fall. But the loss thus experienced bears no comparison to the increase of the produce in grain; besides, it may, in a great measure, be avoided by training the plants a little earlier.

The cultivation bestowed on a bean crop keeps the soil clear and loose during that period; and when the plants come up they overshadow it. By this means it is perfectly prepared for the next crop; and after the beans have been gathered in, requires comparatively little tillage. The extirpator is the best instrument which can be made use of for the purpose of levelling land which has been thrown into ridges by drilled crops. When this has been used, one ploughing will suffice to prepare the land.

When beans are sown broadcast, they are usually mixed with either peas or vetches, and rarely sown alone on account of their success being so very casual.

This plant is extremely subject to attacks of rust or mildew, or both. The former shows itself on the leaves, the tips of which turn brown; this spreads, becomes darker, and finally destroys both the leaves and the plant. Mildew attacks the tops of the plants, and is immediately followed by the appearance of an innumerable quantity of black insects or bugs (*aphides*), which soon extend themselves over the whole of the plant, and prevent it from forming any fruit. Some farmers have endeavoured to diminish this evil by cutting off the tops of the plants with some sharp instrument. I have never found those crops of beans which have been sown with a drilling machine to suffer so much from rust or mildew as those sown broadcast; for, in the former case, the plant is usually pretty strong before the disease appears, and a considerable quantity of its grain is formed; consequently, the ravages are not so sensibly felt.*

In places where the worth of the soil is known, when the bean crop promises to turn out badly, it is immediately cut and the field broken up, and the beans spread in the furrows and covered over, because a poor crop of beans would not repay the injury which they would do to the succeeding wheat crop; for it is well known that it is only those bean crops which succeed well, that form a good preparation for wheat, and that this grain almost invariably fails when sown after a poor crop of beans.

Beans should be got in as soon as the greater part of the pods turn black, and without regard to the maturity of those which were set last. A very clever English agriculturist has even gone so far as to recommend that the beans should be cut as soon as the seed is completely formed, tied up, carried to some place, and there left to ripen, in order that the land on which they grew may be the sooner ploughed up. Beans sown by broad-cast are frequently cut down with a scythe, and then collected and carried out of the field; but a sickle is often made use of. Beans which have been drilled in rows, and especially such as have been well hoed, can only be cut with a sickle; a scythe would break the lower pods, and the beans would then fall into the deep furrows which the hoe had left between the rows, and thus be lost. The best plan appears to me to be to have them pulled up;

* With us the aphides begin to show themselves on the leaves about the 20th of May. At this period the crop should be carefully looked over every day; and if a few lice are perceptible, which usually precede the insects by a few days, women and children should be immediately sent into the field to nip off the top of every bean plant, and carry it away. Where these labourers make use of both hands at once, the work may very soon be done, and at very trifling expense. Everything else must be set aside in order to attend to this, for the loss of a day or two might cause the destruction of the whole crop. I have always found the flowers of plants which had been thus cropped to set better than any others.—French Trans.

but this cannot be done on tenacious soils, at least not without great difficulty.

After the beans have been cut they are tied up in small sheaves, five, six, or seven of which are set up one against the other: when the bean harvest is not succeeded by very dry warm weather, it frequently takes a long time to dry thoroughly. But as it is now well known that it is of the utmost importance that the field should be cleared with as little delay as possible, the beans are often carried to some other place to complete the process of drying.

The produce of beans sown broad-cast is even more casual than that of peas. Where the ground is adapted for them, and the plants are sown in rows, and subsequently cultivated with a horse-hoe, from ten to twelve bushels of grain per acre may be expected. In Kent, and other counties of England in which beans are sown, from eighteen to twenty-seven bushels per acre of our measure is regarded as the ordinary amount of produce.

A bushel of beans weighs from a hundred to a hundred and three pounds. They contain a large proportion of nutritious vegeto-animal matter, although not so much as peas; but a larger quantity of amidon. In many places they are baked, and employed as food; sometimes they are even mixed with flour, and made into bread; and many assert that they communicate a most agreeable flavour to the bread thus formed: but this pulse is chiefly given to horses. In many parts of Germany, beans sown broad-cast are kept expressly for this purpose, without being threshed; and the sheaves are cut up with the chopped straw, expressly to be given to horses. In England beans are regarded as the best of all kinds of fodder, not only for draught, but also for race-horses. They must not, however, be steeped in water, as some persons are too much in the habit of doing, in order to swell them out, but given in their natural state. They are also made use of for the purpose of fattening pigs, and are exceedingly adapted for this; but then they should be soaked in water.

Bean straw is usually considered to be very nutritious, especially when it has not suffered from the effects of unfavourable weather; this, however, depends very much upon the period at which the crop is cut, upon whether it was cut while the haulm was yet green, or later in the season; thus, in the latter case, the leaves will have fallen off, and the stems become hardened. In the former case, bean straw is considered as equal to hay, and is given to horses and sheep as such. With regard to the straw of drilled beans, as I have before stated, it often loses its quality. In this kind of produce the relative proportion of the quantity of straw to that of grain is almost always opposite.

VETCHES. COMMON VETCH (VICIA SATIVA.)

Among the numerous family of vetches there are various kinds which are doubtless useful; hitherto, however, none have been much cultivated excepting the common vetch, the Narbonne vetch (*vicia Narbonensis*). The cultivation bestowed on the latter in no way differs from that bestowed on the former; and as it appears to be in no way superior to the other, excepting in cases where it is wished to cultivate vetches on very rich land, it is but little grown, After several experiments I have given up the saw-leaved vetch (*vicia serratifolia*), on account of its not having come up to my expectations.

There are several varieties of the common vetch. We have a small one which ripens very early, and one, the haulm of which is larger, which ripens late, and requires to be sown very early in the year to ensure its arriving at maturity.

The English autumnal vetch is probably the same as this large variety, but has by cultivation become habituated to passing the winter in the ground. Several experiments which have been made in our climate seem to demonstrate that this vetch is incapable of resisting the winter: it is less liable to be destroyed by sudden hoar frosts, than by late frosts which occur after vegetation has commenced. It not unfrequently happens that even in England it is destroyed by frost; thus the advantage which might be derived from the naturalization of this species would not be very great, since it seldom ripens more than ten days before the spring vetch, when this latter has been sown in good time.

Vetches require a clayey soil, where the land contains more than sixty parts in a hundred of sand, and is not in a very damp situation; this plant will also thrive, provided that the ground is properly ameliorated, and the summer moist: but in dry summers it rarely succeeds.

It does not absolutely require a very rich soil; nevertheless, it always succeeds better, and the haulm is finer, when the soil contains a considerable portion of succulency; it is on this account that wherever it is practicable they manure for this crop.

This plant is now almost as often cultivated for its haulm as for its seed, which former is either used as green meat or reduced to dry fodder; it is cut while in flower, and before many pods are formed.

The cultivation of this crop is in no way distinguished from that of peas; as the seed is smaller, twelve metzen is sufficient for an acre of ground. In order to ensure its attaining maturity, the large vetch ought to be sown at the beginning of April. The small variety will ripen, even when not sown until the end of May; but most agriculturists recommend that the common variety should be sown early. I have, however, observed these crops for some years past, and have always found that where this kind of vetch had not been sown until towards the middle of May, it always succeeded better than when sown earlier. If cold weather comes on, the vegetation of the plants is checked, and then they are very frequently attacked by a worm, which gnaws the buds, and does so much mischief that, if the soil is at all impoverished, the plants never flower; where, however, it is rich, the plants occasionally overcome this evil, and shoot up again. Those vetches which are sown later escape the attacks of this worm, the period of its existence being short.

Where it is intended to use vetches as green fodder, or reduce the crop to hay before it has attained its maturity, it may be sown in any weather up to the beginning of July. In order to be enabled to stall-feed cattle on green vetches, a certain quantity must be sown which will last until the others come up. When intended for this purpose, the vetches are usually mingled with spring rye, barley, or oats; and to these latter is often added buckwheat, in order to render the mixture thicker and richer. When the crop is to be made into hay, it is considered most desirable to sow the vetches by themselves, as it then dries more uniformly. This crop is made into hay in the same manner as clover or lucerne; consequently, I shall refer my readers to the directions which will be given when I come to speak of the haymaking of these two crops. Vetches take longer drying than clover, but are not so liable to be spoiled when the process of drying is not properly conducted.

When vetches are intended for the feeding of horned cattle, in the shape of green meat or dry fodder, they are mown while in full flower; but when they are intended for horses, the pods are suffered to develop themselves a little, because the quantity of fodder is thus increased, and the vetches rendered more nutritious.

The sooner vetches are mown the less do they impoverish the soil. But whenever this plant has been sown, the ground must be broken up directly the crop has been got in; the importance of this course is so generally known and recognized, that all persons who have it in their power, cause the newly-mown plants to be immediately conveyed to some other place to be dried.

When vetches are mown early in the season, and at the time when they are putting forth their first buds, they will shoot again if the soil is rich; but where it is poor, nothing is gained by such a proceeding; on the contrary, the two cuttings together do not amount to as much as would have been obtained from one good crop cut at the usual period.

It is a very bad practice to endeavour to derive advantage from the second shooting of vetches by pasturing cattle on them, as the soil is then hardened by the feet of the animals, and the succeeding crop is thus often seriously injured. Occasionally a second crop of vetches is sown on land which has produced one that has been mown while green; but in order to do this the utmost promptitude is necessary, and not a moment must be lost between the gathering of one crop and the sowing of the other. But, in general, buck-wheat or radishes are sown after vetches which have been cut while green.

The produce of vetches in seed is very unequal. Sometimes as much as twenty-four bushels per acre have been obtained; but eight bushels may be regarded as the average quantity. Vetches grown on rich land have yielded as much as from 1,800 to 2,000 lbs. of straw, comprehending the husks and refuse. The haulm of this crop is preferred to pea haulm for the purpose of feeding cattle. When vetches are cut while green, and at the period when their pods are just beginning to form, 3,000 lbs. of straw per acre are often obtained; but even where the soil is most fertile, it is safest only to reckon on 2,000 lbs. When on account of the spring being very dry the vetches do not succeed, the produce will fall to 1,000 lbs. per acre.

Numerous experiments seem to testify, that when cut while green, vetches scarcely deprive the soil of any portion of its fertility, but that, on the contrary, the succeeding crop has often been found to be decidedly better than one which followed a dead fallow, provided, however, that the ground has been broken up without loss of time after the gathering of the vetches. Vetches which attain maturity, and yield a produce in grain, may, in that respect, be compared with peas. The common mixture of vetches and oats, when suffered to attain maturity, exhausts land much more; and a crop of rye grown on a field which has produced this kind of fodder, and from which it has been mown little by little, as it was required, will indicate very plainly by the difference in its produce which were the spots on which the vetches and oats were suffered to stand too long. In England it is by no means unusual to sow vetches solely for the purpose of ameliorating the soil. In such cases, however, this crop is not ploughed in at once, but cattle intended for fattening, and pigs, are turned on to it; which animals certainly spoil a great deal by trampling it down, but they also consume a great deal. After this the land is broken up without loss of time, and sown with rape. This mode of proceeding is not in some respects so little economical as it appeared to be to a traveller with whom I am acquainted.

When vetches have been left standing till their seed is ripe, they are commonly used to feed horses and fatten pigs; they are also given to sheep, and for this purpose are considered preferable to peas. The seed of this plant is rarely a marketable commodity; it is, however, not unfrequently sold for sowing. Vetches may be kept for a long time, and ultimately sold at a price which yield large interest. In agricultural undertakings in which the production of fodder forms an essential feature, it is advisable to keep a supply of vetch-seed in the granary, because this plant furnishes the best resource when the crop of clover fails.

The straw of vetches which have perfected their seed is more grateful to cattle than that of peas; it is often, indeed, considered equal in value to hay; but it is not to be compared with vetches that have been mown in the green state and made into dry fodder.

There are a few other sorts of pulse rarely met with, and confined to certain localities; such are the Spanish lentil (*lathirus sativus*), and the chick-pea (*cicer arietinum*). The cultivation of these plants differs in no respect from that of peas and vetches, and hitherto I have heard no reason assigned for preferring them to the plants already noticed.

BUCKWHEAT (POLYGONUM FAGOPYRUM).

This plant thrives well on soils which are too poor for all other kinds of grain either of the spring or summer varieties. It grows on dry, sandy soils, provided only that the drought be not felt precisely at the very time when the plant stands most in need of moisture; it then yields as plentiful a crop as any other kind of grain; but if the ground be in a situation somewhat more accessible to moisture, the crop of buck-wheat is so much the more to be depended upon. This plant also thrives on heath and marsh lands, provided that the latter have been previously drained. It is cultivated to great advantage on clearings of this description, and is very useful in preparing the soil for the reception of other kinds of grain.

In sandy districts buckwheat is the only crop which succeeds when sown alternately with rye; in such situations it takes the place of all other fallow crops: it is also sown on lands, where rye has been grown. It, however, thrives better as a fallow crop on land which has been used as pasturage, or left in repose for a few years.

On richer soils the plant grows more vigorously, but only in the haulm, rarely producing so much seed as when grown on poorer soils. A small quantity of manure is advantageous to it; but a large quantity makes it grow too strong in the haulm. When the land on which buckwheat is to be grown requires manuring, it is usual to give it only half the usual quantity, the remainder being reserved till after the harvest.

Manure furnished by furze, a plant which is always abundant in districts where buckwheat is grown, is particularly well adapted to this kind of grain.

The sowing of buckwheat, even on the lightest soils, must always be preceded by two ploughings, in order to destroy the weeds.

This plant, which was brought from the East at the time of the crusades, has not yet lost its sensibility to cold; the slightest hoar frost destroys it. The sowing must therefore be deferred till all danger of cold nights is over. I have, however, known buckwheat to be destroyed by frost as late as St. John's day. It should not, therefore, be sown earlier than the middle of May, or later than the middle of June;* for, if sown at a later part of the season, it will be liable to be attacked by the white frosts of autumn before its seed is ripe, and then the quantity of grain will be much diminished. The quantity of seed sown on a given extent of ground is about the half of that used in sowing wheat: sowing more thickly is injurious to buckwheat. In countries where this plant is sown in large quantities, they treat it as if it said to them, "Make room for me, I am coming up."

The success of buckwheat is remarkably affected by the weather to which it is exposed in the several stages of its growth; in this respect it is more susceptible than any other kind of grain. It requires dry weather immediately after sowing, and springs up during the time of greatest drought; but after putting forth its third leaf, it requires rain in order that its leaves may be developed before the appearance of the flower, which soon follows. During the long time for which it continues in flower, this plant requires alternate rain and sunshine to facilitate its growth and enable the flowers to set. The flowers drop off during thunderstorms, or even on the occurrence of electric phenomena unaccompanied by rain. Buckwheat is also incapable of withstanding violent easterly winds, which cause it to wither before its flowers are set. After flowering, the plant again requires dry weather to bring all its seed to maturity at the same time, and ensure an early harvest.

The success of buckwheat is, therefore, very precarious. It depends not only on the general state of the weather throughout the season, but also on the particular time which may have been chosen for sowing. A week earlier or later often makes a very great difference. Hence

* Throughout at least the half of France, in the South of Switzerland, and generally in countries where the corn is housed about the middle of July, and the hoar-frosts seldom begin before the 24th of Oct., buck-wheat may be successfully cultivated as a second crop, after wheat or rye. In these countries the corn is carried, and the land ploughed up with all possible speed; the seed is then sown after one ploughing, and carefully covered up with the harrow. This plant remains in the ground for ten weeks, or three months, from seed time to harvest.—FRENCH TRANS.

those who wish to make sure of their crop of buckwheat sow it in three or four separate portions, and at different times.

The seed should be simply covered up with the harrow, and not in furrows. I have also found that the use of the roller is injurious.

The ripening of the grain is very unequal; for the plant is continually flowering and setting. We must, therefore, cut it at the time when the greatest quantity of grain is ripe. It sometimes happens that the first flowers do not set, or that they produce nothing but barren seeds, destitute of farina, while those which come out later yield better seed. But the grain will ripen, and even the flowers set, while the crop is lying on the ground after cutting, especially if rain fall. This occurrence is, therefore, considered favourable.

The produce of buckwheat is, as just observed, very uncertain. When it is sown after a corn crop, one good harvest may be expected in about seven years; in the same interval we may reckon upon three medium and three bad harvests. But when buckwheat is sown on land which has been left in repose, or laid down to grass for a few years, we may reckon upon one good crop out of two. Extraordinary crops, amounting to twenty bushels per acre, are but very rarely obtained.

In many countries, buckwheat furnishes an important article of food for man; and, when cheap, is also used to fatten cattle and feed horses. Its price falls very low in years of plenty, but rises again in seasons of scarcity. Cultivators who have the means of keeping it often lay it up in store; it is well adapted for this purpose.

The straw of buckwheat is much esteemed; it is nourishing and wholesome for cattle of all kinds. It should, however, be consumed before Christmas.

Indispensable as this plant may appear in some countries, its cultivation for grain is so precarious in others, that we can scarcely venture to recommend it. As a fodder-plant, however, it is excellent; and, when cultivated for this purpose, may be depended upon as well as anyother plant. We may sow it as late as we please; the haulm is sure to be good, provided only that there be no danger of frost, and that the soil contain a moderate quantity of moisture. It may either be given to cattle as green-meat, or else made into hay. It dries but slowly, but does not spoil when left on the ground without being turned. When treated by Klapmeyer's method, it is likely to turn out very good.

The cultivator who wishes to raise it for this latter purpose should choose a year in which the plant has been particularly successful, in order to obtain a good supply of seed; this, he will find, will yield him as good a return as any other. Buckwheat raised for this purpose may be sown on the stubble of a corn crop; or still better after vetches which have been mown early in the season to be consumed as green-meat.

A mode of proceeding which I have found perfectly successful is, to sow buckwheat in July, together with St. John's day rye; then to mow the buckwheat in the green state, and reap the rye, when the grain is ripe, the following year. This may be done very advantageously on land which has borne a crop of vetches cut in the green state. Radishes may also be sown amongst buckwheat.

This plant is also well adapted for sowing, as a preservative crop, either with clover, or, still better, with lucerne. We shall have occasion to recur to this matter.

The produce of buckwheat as a fodder-plant is, however, very different, according to the circumstances under which it is grown. I have obtained crops of it, exceeding in weight those of vetches grown on the same soil, and to all appearance by no means inferior in nutritive power.

Some persons recommend a kind of buckwheat known by the name of Siberian buckwheat (*polygonum Tartaricum*). This variety has the advantage of passing the winter under ground. Two crops may, indeed, be obtained from it; but, after repeated trials in the open field, I have found its produce so insignificant, and the crop, especially in the second year, so infested with weeds, that I cannot, by any means, acquiesce in the elaborate praises which others bestow upon it. In gardens, where it can be weeded, its growth is doubtless very fine.

MESLIN.—MIXTURES OF DIFFERENT KINDS OF GRAIN.

In many countries it is customary to associate different kinds of grain, and likewise different sorts of legumes; and even to cultivate grain and leguminous plants together. Many practical cultivators say that they have obtained a more abundant produce by this method than by the separate cultivation of the same kinds of grain. This assertion is certainly not without foundation: I have frequently made experiments, which remove all doubt of its correctness. It often happens that the seeds of both the plants which have been sown together thrive equally well, and the quantities of the two plants contained in the crop are in proportion to the quantities of the respective seeds. At other times one kind will succeed remarkably well, and almost choke the other; in such a case the quantities of the two plants in the crop are by no means proportioned to those of the two kinds of seed: this is particularly the case when the state of the weather has been peculiarly congenial to one or other of the associated plants. In such case there is this decided advantage, that when the weather is unfavourable to one of the plants it is by so much the more congenial to the other; the latter consequently grows more vigorously, and obtains a better supply of nourishment on the ground which it has won by the failure of its companion; moreover it cannot be denied that certain plants absorb substances which are not adapted for the support of others.

It must, however, be understood that plants thus associated must be such as ripen about the same time. If the seasons of their maturity are not exactly the same, the crop must be gathered when the plant which grows the more vigorously or ripens the more quickly of the two has attained that stage; in such a case the other will perhaps ripen after it has been cut down, or it may be useful although it has not attained its full maturity. Many mixtures of this nature may be separated by the sieve, or by the operation of *fanning;* but the seeds are commonly used together.

It has, however, been observed with some reason that mixtures of this nature are peculiarly trying to the soil, although at the same time it must be admitted that they yield an abundant supply of straw for the production of manure. It is said that the cultivation of different plants together preserves the soil from weeds; this may be true in certain cases.

The most usual mixture is that of wheat and rye; known by the name of *meslin.* This mixture is very common in some countries, more so indeed than pure rye. It is used to make ordinary bread, which is said to be particularly nutritious and agreeable to the palate. In the Netherlands, on soils no longer fit for the growth of wheat, this kind of cereal produce mixed with rye is said to yield more than it would if grown by itself; and, moreover, not to diminish the quantity of rye in the crop. Meslin is usually sown after a crop of wheat. In other countries spelt is mixed with rye instead of wheat; these two kinds of grain are easily separated.

Flat barley and oats are also grown together; and, from my own experiments, I should say that they are well adapted for this purpose. If the soil be favourable to barley, this plant growing more vigorously will choke the other to a certain extent, if at least the weather be somewhat favourable; in the contrary case, the oats being the more hardy of the two will usurp the place of the barley, and when threshed will yield perhaps four times as much as the latter. Whenever I have grown these two plants together I have obtained better crops, as regards both weight and value, than from barley and oats separately cultivated and reaped. I must, however, confess that I have never made the experiment on a soil peculiarly well suited to the former of these plants. Some persons add spring-rye to this mixture when grown on light soils.

Amongst the mixtures of grain with leguminous plants, the most common is that of oats and vetches. They are frequently cut with the chaff-cutter without being previously threshed, not only when they are left to ripen and used as fodder for the cattle, but also when they are mown while green and given to the cattle in that state, or else made into hay. Vetches find better support when grown with oats, than when alone. Barley and spring wheat are also mixed with them.

It is not unusual to sow peas in small quantities among spring-wheat; it is said that the quantity of wheat is not thereby diminished, and that the peas are obtained in addition. This proceeding is usually resorted to on soils on which it is not thought safe to venture upon the cultivation of peas. On sandy soils, peas are associated with spring-rye. The peas thrive when scattered among these grain crops, which they would not do if they were alone. By the use of the fan, the peas may easily be separated from the corn.

On calcareous, clayey, and meagre soils, especially on declivities, it is usual to sow beans among a crop of oats. In many countries it is not uncommon to meet with a mixture of beans, vetches, beans, and oats, sown at random on the fallow of a rich soil. This mixture produces a close mixed crop of plants, which, being supported by the beans, maintain their erect position, and yield a larger quantity of fodder than any other plant that can be sown for this purpose. The crop is rarely allowed to ripen, but is cut as soon as the seed is formed. It is not threshed; or, if this operation is performed, it is done very lightly, to separate the ripe seed, and the straw is chopped up and used to feed cattle. It is with this kind of food that horses are entirely fed in some countries: it frequently goes by the name of *beans*. The relative quantity of each kind of seed to be sown for this mixture is determined by the nature of the soil. In argillaceous soils the quantity of bean-seed sown is the greatest; in soils of a lighter nature, more vetches are used.

Vetches are also mixed with buckwheat, especially when the crop is to be cut in the green state.

CULTURE OF HOED OR WEEDED CROPS.

This denomination includes a great number of plants, which, though they belong to different classes as regards both their nature and uses, and in a botanical as well as in an economical point of view, may yet be classed together, as far as their mode of cultivation is concerned. To avoid the necessity of repeating the same details in what we shall have to say upon the cultivation of each of these plants, it will be proper to begin by describing the various operations belonging to this department of cultivation, and the implements with which they are executed.

In the latter stages of their growth, these plants require a much greater space than that which they occupy on first coming up; they must, therefore, be sown or planted with proper distances between them. But the intervening spaces would be occupied by weeds, which would soon choke the crop, or at least deprive it of its due supply of nutriment, if after the sowing or planting both soil and crop were left to nature. Now, to have all these weeds pulled up by hand would not only be too costly, but, moreover, would not fulfil another condition which ought to kept in view, viz., that of lightening the soil and preparing it for subsequently affording nourishment to the plants. Consequently, since the time when these plants were first cultivated, particularly in gardens, it has been thought necessary to raise and lighten the soil with hand-hoes and mattocks of various kinds, by means of which the light soil is heaped up around the plants as they grow. The complete and proper performance of this cultivation, and its frequent repetition, have always been regarded as essential to the success of the crops of which we are speaking.

But these operations, if executed by manual labour, would require so many hands, that the raising of such crops on a large scale and in the open field would be impracticable. Nevertheless, as the advantages of this mode of tillage became obvious, and especially as the cultivation of potatoes became more and more extended, cultivators began to employ in its execution the binot and other implements of the plough-construction which they had at their disposal. Many cultivators made modifications in the binot to adapt it to these operations. My own alterations in the Mecklenburg binot, as described in my edition of Bergen's work on the management of cattle, having been approved of, the instrument thus modified got into general use under the name of the "potato-hoe." I have since improved it, particularly by shortening the trace-bar, and rendering it more independent of the team, so that the machine is more under the power of the driver. I have since found it advantageous to do away with the iron point which was placed in front to enable the instrument to penetrate the soil, and to substitute for it a broader and less pointed share, by means of which a greater quantity of mould is raised out of the furrow and turned over on its sides.

This machine has also been furnished with moveable mould-boards, which, by means of a regulator, may be separated to a greater or less distance at their hinder extremity: they are made of cast-iron. No particular instructions are necessary with regard to this matter; the machine, having met with general approbation, I have been unwilling to render it more complicated for fear of hindering its general adoption.

The English implement, known by the name of the "double mould-board plough," is still better adapted for the operation of earthing up. It raises and heaps up a greater quantity of mould, makes deeper furrows, and, when its mould-boards are separated to a greater distance at the back, it is more effective in tearing up weeds which attach themselves to it. The cultivation of hoed crops may, by the aid of this machine, be executed with a degree of perfection unattainable before its invention.

This instrument is, however, rarely used for the first performance of the operation of earthing up, partly because there is no necessity for executing this labour very completely at first, and partly because the machine requires two horses to draw it; whereas, the light horse-hoe previously mentioned requires but one.

But there are many plants which require cultivation before earthing up, not only that they may be freed from weeds, but also that the earth which is to be laid up to them may be previously lightened, pulverized, and aerated, and its nutritive parts rendered more soluble. For these purposes, a swing plough is sometimes used to remove the earth which lies close to the plants, and turn it over towards the middle of the space between the rows. In this operation the plough is passed with its flat side as close to the rows as is possible, without injuring the roots of the plants. To obviate the danger of uncovering these roots, the operation is at first performed on one side only, and five or six days after on the other: there is thus formed a ridge of light soil in the middle of the intervening space. After the ridge has remained in this state for a certain time, it is again turned up with the double mould-board plough, which throws it once more against the plants; these plants can then extend their roots into the freshly turned up soil.

Whatever may be the efficacy of this operation when properly performed, we cannot deny that it is attended with great difficulties; particularly that it requires skilful ploughmen, and a judicious selection of the time for its performance; for which reasons, especially if the soil be moist and tenacious, and the weather unfavourable, it is very delicate, and demands on the part of the operator a certain practical tact and a considerable degree of attention, without which it may easily be converted into a source of injury. Besides this, it cannot well be resorted to when the distance between the rows falls short of two feet; and as the soil requires to be removed at different times from the two sides of the rows, the operation likewise takes up double time.

The destruction of weeds, and the lightening of the superficial stratum of the soil, may be effected in a manner less complete, perhaps, but sufficient in most cases, and much more easy of execution, by the use of implements which merely scarify the soil, but at the same time bruise and pulverize it. Various implements of this kind are in use.

If it be thought sufficient to rake up the weeds and merely scarify the soil, flat shares are to be used; but if it be necessary to turn up the soil to a greater depth, and pulverize it, the shares must be convex, and the plough deeper. The former method is adopted when the plants are young, in order to avoid the risk of burying them under the mould.

There is also used for this purpose an implement furnished with a large rake, or sometimes a scraper, similar to that which is used for raking garden walks. In case of necessity, such an instrument may be drawn by men.

Lastly, a common swing-plough, furnished with a two-edged share, but no mould-board, may also be used for this purpose.

These machines have received almost innumerable modifications, and have been designated by a corresponding variety of names; but there is no essential difference between them. They all require to be modified according to the stiffness of the soil and the state of growth of the plants which are to be cultivated by them. For this purpose different pieces of iron may be fitted to the same frame-work; but, as the frequent shifting of the iron-work is trying to the instrument, and occasions loss of time, I think it better, at all events when the extent of ground to be cultivated is somewhat considerable, to have a number of these implements ready for use.

Cultivation with implements of this description bears the same relation to that which is performed by manual labour that ploughing bears to spade cultivation. The use of cultivators or horse-hoes of various kinds can alone render the raising of hoed crops practicable on the large scale in the greater number of agricultural undertakings.

With one horse and an experienced driver, seven acres per day may be cultivated without extraordinary effort, provided the horse be well trained to the work; for, since the horse-hoe is drawn over three plough-furrows at once, the extent of ground which the horse and driver have to go over in cultivating these seven acres is not greater than that traversed by the plough in ploughing two acres and one-third, and the force which a horse exerts by drawing either the small horse-hoe, or the horse-scraper or rake, is scarcely equal to that of one of the pair employed to draw a plough. Frequently, however, only five acres are cultivated in a day; but this is certainly the minimum. As this operation requires to be executed with a certain degree of circumspection, the driver ought not to be hurried for fear that he should spoil his work by endeavouring to do it too quickly. Moreover, the quickness with which cultivation with the horse-hoe can be executed, depends, as in ploughing, on the length of the furrows, and the necessity of turning more or less frequently. If the men and horses are not accustomed to the work, or if the plants are not sown in straight lines, it is better to employ two men, one to guide the horse, and the other the machine. If a slightly-made and clever lad can be employed in the work, it is best to let him mount the horse, because he then sees better before him, and can guide the animal with greater facility. If the machine be made to pass a second time in the same direction, the conductor may be dispensed with, for the horse is sure to follow the track already made. For the large plough used for earthing up, especially if it be required to cut deeply into the ground, two horses are, however, required: they may be harnessed to it by means of a trace-bar long enough to enable the two horses to walk in the furrows on either side of that in which the plough is at work.

The smallest amount of work that this machine will perform is equal to that of forty labourers; for, in order to do the work at the same rate, at least eight labourers per acre would be required.

In the cultivation of weeded crops, it is often of less importance to obtain the greatest quantity of producc that a given extent of ground is capable of yielding, than to obtain the quantity which is absolutely wanted at the smallest possible expense. The rent of land is much less than the cost of labour, and as these crops are intended to take the place of the fallow, and answer the same purpose, they ought not to be charged with the ground-rent. If I get 200 quintals from an acre of ground, at an expense of twelve rix-dollars, and 50 quintals at a cost of only three rix-dollars, the advantage may very possibly be on the side of the latter, especially if I have plenty of ground ready for use, and requiring this kind of cultivation, but scarcely a sufficient number of labourers for sowing and cultivating a larger extent of surface. Plants sown with tolerably wide spaces between them may be cultivated much more effectually than those which are very crowded.

It is absolutely necessary that all weeds appearing above ground be utterly destroyed a short time before the planting or drilling of the vegetables of which we are speaking, in order that there may be no necessity for raking or hoeing before the plants have acquired a certain degree of strength. The soil must of course be previously well prepared with the plough, but, after the last ploughing, it is advisable to level the surface with the harrow, then, in dry weather, to pulverize the clods with the roller, and harrow again with considerable force. By this treatment the weeds are made to germinate quickly; and when their germination has taken place, the sowing or planting is preceded by cultivation with the extirpator, after which the ground is again harrowed. Even if the reappearance of weeds cannot be entirely prevented by these precautions, it is at all events retarded, and the quantity of the weeds diminished, so that in many cases the use of the rake may be dispensed with, and the operation of earthing up proceeded with at once. The cost of these preparatory labours is largely repaid by the saving which they effect in the after cultivation.

An implement of the greatest utility in the raising of hoed crops, is the furrower, or marking-plough; which, however, ought to furrow more deeply than the instruments of this name in common use. It may be made of iron, or of wood covered either with iron plate or with cast iron, as recommended by Fellenberg. With this implement lines are traced in a certain direction; and by means of a cord stretched across, the exact place is marked which each of the plants is to occupy. In order to vary the distance between the rows, we must either employ another instrument, the feet of which are placed at the required distance, or have the former made with moveable feet, so that the distance between them may be modified according to circumstances. In the small furrows made by this machine, the plants are arranged in parallel lines, and at the same time sown rather more deeply than they otherwise would be. They are thus, to a certain extent, protected against drought, enabled to absorb a greater quantity of moisture, and ultimately covered by a greater quantity of light soil. When the seed is small, it is deposited in these furrows, either by hand or with the drilling machine; but the furrows must be made immediately before sowing, in order that the soil in them may remain fresh and light.

For weeded crops which are sown far apart, and raised from seed on the spot on which they are to attain their full growth, it is usual to employ simpler drills, which sow but one row at a time. Machines of this kind have been invented for sowing two or three rows at once. No advantage has, however, been derived from them; on the contrary, they have been found inconvenient from not admitting of any alteration of distance between the rows, according to the nature of the crop and the fertility of the soil.

When seed-beds are formed, from which the plants are to be removed after a time and transplanted to the ground on which they are to attain their full growth, the seed is either spread uniformly or sown in close furrows, in order to increase the facility of destroying the weeds which grow up with it.

If we have made up our minds to cultivate these vegetables, and chosen and prepared the land on which they are to grow, it is very annoying to find ourselves short of plants. It is, therefore, of the utmost importance to provide good seed; to raise it, as far as possible, ourselves; or, at all events, to purchase it of cultivators upon whom we can depend, and not of seedsmen, who are often themselves deceived in its quality. But it sometimes happens that, though we have used the best seed, still the seed-beds are deficient. Plant-lice (aphides) are very destructive to the plants; especially to those of the radish and cabbage tribe, at the time of their germination. When the weather is warm, there is, perhaps, no better method than to cover the beds with boughs of trees, place straw upon them, to the thickness of about an inch, and keep it constantly moist until the plants shall have put forth their fourth leaves; after that, the insects may, indeed, attack the plants, but they will not easily destroy them.

It is absolutely necessary to select for the seed-beds a soil well prepared, *between the wet and the dry;* not recently manured, but yet rich and fertile.

There are some plants that should be sown as early as possible. They may be protected from frost, occurring in the latter part of the season, by the coverings above-mentioned. Hot-beds are certainly very convenient, but they can scarcely be used on the large scale. The more there is to be apprehended from plant-lice, the earlier should the seed be sown, in order that a second or third sowing may take place, if required. A supply of seed should always be kept for this purpose.

On the average, we may reckon that, to produce plants sufficient to cover an acre of ground, the extent of the seed-bed must be four square perches. Sometimes, indeed, this extent of ground yields a superabundance of plants; but the waste is very trifling, since these plants may be set in other situations, or even used as green-meat.

If we take the trouble to pull up the weeds out of the seed-bed, we obtain more healthy plants as the reward of our labour. I have often contented myself with mowing down the weeds which grew more vigorously than the plants of the seed-bed; and, in my opinion, this method is sufficient.

When the seedlings have attained a due degree of vigour and hardihood in the seed-bed, they should be transplanted as soon as possible, to prevent their stems from growing too long. If the weather be mild and damp at the time of transplanting, the labour and difficulty of the operation are greatly diminished. All the available hands must then be employed upon it, in order to take advantage of this state of the weather: it is even advantageous to engage as many additional labourers as possible, in order that the transplanting may be promptly executed. The cost of this labour is much diminished by properly dividing it, so that each man may perform his part without delaying or hindering the others. It is true that strict surveillance is required for the attainment of this object; but it is better to institute this superintendence, and have the work quickly executed, than to allow it to be uselessly protracted for want of proper management. A certain number of men should be employed to take the plants out of the seed-bed. If the soil be hardened, though in ever so slight a degree, the plants must not be forcibly torn up; but the earth around them must be loosened with a spade, and thrown on one side, so that they may be taken up with care, and without injury to the fine filaments of their roots. A bucket is then to be filled with a semi-fluid composition, consisting of marly clay, which mixes readily with water, cow-dung, or fermented dung-water, and a quantity of water just sufficient to give the mixture such a degree of consistence that when the roots of the plants have been immersed in it, these roots and their most delicate filaments may remain coated, and, as it were, completely enveloped by it. The next thing to be done is to take a handful of plants, and, after having cut off the ends of their leaves, to plunge the roots in the semi-fluid mixture; these plants are then to be placed handful after handful in a basket, and carried to the field on which they are to be planted.

This mode of covering up the roots is both simple and effectual; it completely protects the plants against the injurious action of the air, keeps them moist, and provides a proper quantity of nutriment for the most delicate filaments of their roots. Plants thus prepared may without injury be left out of the ground for several days, if they are to be carried to a place at some distance off: it is, however, undoubtedly better to plant them immediately. If the ground be moist, and the sky overcast, the plants which have been put into the ground will not require watering, but will remain standing without it; and thus a great deal of trouble will be saved.

The number of persons employed to carry the plants to the field must be regulated according to the extent and distance of the plantation. These persons may, on arriving at the field, distribute the plants to those who are occupied in setting them; or there may be a man specially employed in carrying the plants from the basket, and distributing them as they are wanted.

In the plantation itself, the labour may be divided between those who make the holes in the places indicated by the marking-plough, and trim the plant by again thrusting their dibbles into the ground, and pressing the mould against the roots, and those who place the plants in the holes. But it is necessary that the labourers should be well practised in the work, that they may not hinder or delay one another; otherwise it is preferable to let the same man make the holes, and put the plants into them. Each labourer, or each pair of labourers, is employed on one row only at a time, unless the plantation is to be very thick: in that case each takes two rows. The labourers work bias, following one another both in going down the field and in returning: they should always be kept as much as possible in these relative positions.

It is usual to make the holes and trim the plants with a wooden dibble, furnished with a proper handle: but it is better to use an iron tool, by which, if a little expertness be acquired in using it, the operation of planting is greatly facilitated. The planter cultivates the soil with it: he shifts the instrument a little from its place, introduces the plant into the hole, stirs the mould around it to enable it to slip into the hole, and again thrusts his dibble into the ground, so as to press the earth against the roots without injuring them. If the labourers are unskilful at this operation, it is doubtless better to fit the dibble with a straight handle, having at the top a little cross-piece on which the workmen can lean, in order to thrust the implement more firmly into the ground. The soil is not so much hardened by this instrument, as it would be by a round piece of wood.

If the soil is dry, the weather warm, and the sun powerful, no time must be lost in watering the plants after they have been placed in the ground: the water for this purpose is carried to the plantation in bucking-tubs. In such a state of the weather it is advisable not to plant in the early part of the day.

Even when the planting has succeeded as well as can possibly be expected, there will always be a deficiency of a few plants, arising from their not having taken root, or having been destroyed by accident. As soon as this deficiency is perceived, fresh plants must be put into the ground with all possible expedition; for, if this operation be delayed, the plants afterwards introduced to fill the vacant spaces will not grow to the same height as the others, but will, on the contrary, be choked by them. Sometimes, however, before replanting, it is advisable to rake the ground with a horse-rake, otherwise the plants recently put in might easily be buried under the earth turned up. Good and healthy plants must be kept ready for this purpose: it is useless to plant those which have been left behind on account of their weakness; they would have no chance of succeeding.

These vegetables are usually planted on unbroken and level ground, or else on ridges or lands of various widths. But it is also the practice to plant, and even to drill, on very narrow ridges previously formed by the plough. The object of this method is to supply the roots from the beginning with a thicker stratum of humus. The best mode of forming the ridges is to use the large double mould-board plough, which does the work very well. Sometimes the roller is passed lengthwise over the ridges, in order to depress their crowns a little. This mode of cultivation is often highly successful, because the roots meet with nothing but light and fertile soil to a considerable depth, and thus have more room to spread. But the difficulty of destroying weeds is at the same time increased; and it becomes necessary, either to resort to the method described at p. 490, or else to seize the moment when the greater number of weeds which show themselves at the surface of the ground have germinated and put forth their seed-leaves; and then with the same plough that has been used for forming the ridges, care being taken to separate the mould-boards to a somewhat greater distance at the back, the furrows are again turned up, and the young shoots thus covered with fresh mould brought up from the bottoms of these furrows. On the tops of the ridges in the rows in which the plants grow, the weeds are soon destroyed with the hand-hoe. But if the favourable moment be allowed to pass, the removal of weeds becomes very difficult, because it then becomes scarcely possible to use either the paring-plough or the horse-rake for this purpose. I have always obtained excellent crops by this method. It is not, indeed, applicable to dry, loose soils; but, on the other hand, it is excellent for those which are moist and tenacious.

The machine for drilling at wide intervals may also be used for sowing the seed of these plants in ridges; and as the thickness of the vegetable soil is considerable, the success of the method is as great as can be wished; but the difficulty of keeping the soil free from weeds is even greater than when other methods are employed. According to my own experience, indeed, I should recommend that this method be adopted only on soils which have previously been well weeded.

It is recommended by some cultivators to place all the manure, especially when the quantity of it is insufficient, exactly under the rows, in order that the plants may derive the greatest possible quantity of nourishment from it. The method pursued is as follows:—In the first place, furrows are made with the double mould-board plough as nearly as possible in straight lines, and at equal distances. The dung is then brought in a cart drawn by one horse, but wide enough to admit of the wheels running in two furrows, one on each side of that in which the horse walks. A man following the cart draws out the dung in such a manner as to make it fall into the middle furrow in little heaps, at small distances apart, while two others spread it in the three furrows at once. The dung used for this purpose must be free from straw. When it has been thus spread out, the interfurrows are turned up with the same plough, which is now made to enter as deeply as possible, and the dung is thus covered by the mould taken out of the new furrow. Afterwards the roller is passed over the ground in the direction of the ridges in order to depress them, and the vegetables are sown or planted on them. The plants are thus set exactly over the manure.

The advantages of this method do not, however, appear to me so great as many persons assert. I prefer first to carry all the dung on to the field, and then to mix it with the vegetable soil by repeated ploughings. This method, even if not more advantageous to the hoed crop which immediately follows its application, is certainly more beneficial to those which come after; and it is to these latter that attention should chiefly be directed. When the plants are earthed up, they always get access by their roots to the manure which is mixed with the vegetable soil, since the whole of this stratum is heaped up close to them. On the other hand, although this operation is not difficult, it is very tedious, and causes considerable delay. I have tried it but once, and I therefore hold my opinion subject to correction, according to the results of well-conducted experiments.

Finally, it must be remembered that all these crops require the land to be deeply ploughed.

VEGETABLES FOR THE MARKET.

Many of these may, by cultivation with the horse-hoe, be raised to great advantage.

The pecuniary profit arising from the culture of *vegetables for the market* is, in some cases so extraordinary, that we cannot but wonder at the limited extent of this branch of husbandry, which is, in fact, confined to certain countries, and even there limited to particular kinds of produce. In many countries it is almost or even entirely unknown, although vegetables of this description are often very much wanted, and must be procured from foreign countries, after having passed through the hands of several traders. In many countries, in consequence of the practice of this branch of husbandry, the value of the soil or the rent of landed property seems capable of surpassing the highest rate that it has ever yet attained, even at a time when this rate would otherwise fall with the diminished price of grain. The greater the depression in the price of grain, the higher is the profit derived from these vegetables, because, when the price of corn falls, that of labour falls with it. When a naval war throws obstacles in the way of the exportation of corn, which is always the basis of the active commerce of Germany, the price of grain falls, while the value of these vegetables rises, a circumstance which greatly increases the importance of their cultivation at such a time. It is, undoubtedly, by this description of produce that the skill and energy of the cultivator are best repaid. Why, then, do not all agriculturists avail themselves of this source of profit, more especially at a time when they have so much reason, as they have had from 1809 to 1811, to complain of the low price of the more ordinary kinds of produce?

The neglect of this branch of husbandry arises, no doubt, from the various difficulties connected with it—difficulties which many cultivators know not how to conquer, and, in meeting which, they follow the example of other persons who have met with nothing but ruin in the pursuit of this branch of agriculture.

Almost all plants of this description require a soil which is either naturally fertile, or has been greatly improved by careful tillage. They require abundance of manure for the production of which they do not, like grain and fodder-plants, afford the primary material. Hence, the agricultural circumstances of some countries are directly opposed to the practice of this branch of husbandry; which is consequently limited to particular districts, where natural fertility of soil, situation, or an improving system of tillage continued for a long series of years, has produced a superabundance of manure. When, without attending to these circumstances, a cultivator, led away by the great profit which the culture of these vegetables seemed likely to yield, has undertaken to raise them in large quantities, the profit at first arising from them has, perhaps, been enormous; but subsesequently, the establishment, taken as a whole, has been exhausted and weakened to such a degree, that the final result has been decided loss. Many cultivators have realized as much as thirty or forty rix-dollars per acre net profit in this way, and have afterwards been utterly ruined. The first essentials towards the raising of these vegetables in large quantities are, then, a soil in good condition, and a superabundance of manure of the kind required by the very crops which form the raw material of manures. A system of husbandry founded on the continued production of a large quantity of fodder, and the preservation of the fertility of the soil, are absolutely necessary for the safe cultivation of vegetables for the market, unless, indeed, the land be favoured by nature in an extraordinary degree. If the soil can be abundantly replenished with the substances which these plants take from it, the greater number of them will keep it clean and light, either by their own action or in consequence of the cultivation which they require; they also afford an excellent preparation for those kinds of produce which are more commonly raised in the field.

Moreover, the cultivation of vegetables for the market requires an exact knowledge of their nature, and of all circumstances connected with them. A person not possessed of this knowledge is very likely to neglect some point or other, which, at first sight may appear indifferent, but which, in reality, has great influence on the success of the crops. The greater number of them must not, like cereals, be left to themselves during the time of their growth: the cultivator cannot say, when seed time is over, " My seed is sown: God will give it increase:" on the contrary, plants of this description require continued attention, and repeated culture. It is true that the total amount of labour required for this purpose is in many cases but trifling: but the operations of which we are speaking are not on that account to be dispensed with; and what is more, they must be executed at certain precise times: the delay even of a single day may often be attended with the most mischievous consequences, particularly if it be necessary to take advantage of a favourable state of the weather, and a particular degree of humidity in the soil, which last but for a short time. Whoever undertakes this branch of husbandry on a large scale, must be able to comprehend at a glance the whole space over which his operations extend, as precisely as a gardener surveys the limited extent of ground on which he works: he must give to his produce all the attention which it requires, and, as far as possible, remove from it all that may be hurtful.

It is not sufficient to calculate the mere cost of the operations which must be performed by manual labour and with the aid of horses. The time over which these labours extend is very short. Trifling as they may be in the sum total of the labour required, they are, nevertheless, very troublesome at the precise moment when they are wanted. They occur at a time when all the available resources are required for gathering in the ordinary produce; and the cultivator may, therefore, be reduced to the alternative of sacrificing either the one or the other. Hence, in the culture of each of these vegetables, it is necessary to calculate when this particular time will arrive, and how the operations then required can be reconciled with those of other parts of the economy. An extraordinary state of the weather may retard the proper period: generally, however, the rates of growth of different plants appear to preserve the same ratio one to another; so that, when one is accelerated or retarded in its growth, the others are affected in a similar manner. But we must know how to calculate accordingly the time for sowing or planting, and always be in advance with each operation. A harvest as much before the usual time as that of 1811 causes a very troublesome interruption in the regular succession of agricultural labours.

The difficulty of this calculation increases with the number of marketable vegetables cultivated together. If a selection can be made in such a manner that the operations required by the different plants which are raised together shall follow one another conveniently, a great variety then becomes advantageous, and accords well with the general circumstances of the establishment. The same labourers may then be constantly occupied in the same kind of work, and thus be rendered more skilful at it: and, moreover, wherever there is a continued supply of work, a sufficient number of labourers may generally be obtained for moderate wages; but there is always a difficulty in obtaining them when they can be employed but for a short time, particularly if they are of that class who may be entrusted with operations requiring particular attention and long practice.

A cultivator who does not know how to make a judicious selection, but is induced, regardless of the preceding considerations, to cultivate those vegetables only which yield the largest return when perfectly successful, will not fail to pay for his imprudence by serious losses.

But few of these vegetables can be taken to market immediately after they are gathered; they require storehouses to keep them in, as well as particular implements and modes of treatment; and these store-houses must often be built on a very large scale. Now, all these things demand considerable outlay; and when such undertakings are limited to the production of a single species of vegetable, the capital soon becomes loaded with a very heavy interest. Commercial fluctuations, too, may reduce to nothing the profit anticipated from the production of this particular article, and then all the capital invested in it is dissipated. Establishments for the production of vegetables for the market must, therefore, be so ordered as to admit of the culture of different species, either at once or in succession.

A prudent cultivator can never be at a loss for a market to dispose of all his useful produce; but it may happen that many portions of it do not admit of being immediately sold to the consumer, but must previously pass through the hands of the merchant. Now, the merchant is not to be blamed for so far acting up to the first principle of his trade, viz., to *make the most of every thing*, as to endeavour to buy at the lowest possible price, and to take advantage of the cultivator's embarrassment, especially when the latter is in want of money. It is therefore necessary, before we undertake to raise produce of this description, particularly in countries where it is not in actual use, to make ourselves acquainted with the mercantile circumstances of the country, and, as far as possible, to make sure of a purchaser beforehand. Should this be impossible, operations must be restricted to the production of those vegetables, the sale of which is, to a certain extent, fixed in the country; and such are always to be found.

The price of this produce is always fluctuating: we can never reckon upon the maximum of a series of recent prices; for, indeed, it is precisely the existence of a very high price which soon brings on a very great depression; because, all who are able to produce the article in question are induced by the high price to devote themselves to its cultivation, and, consequently, the market is completely glutted with it. It is often prudent to check the production of one plant, in order to increase that of another, when the demand for and price of the former have risen to such a height as to induce every one to speculate in it. On the other hand, a prudent cultivator will not easily be induced to abandon altogether the production of a plant of first-rate utility, and break up all the arrangements which he has made for the purpose, even when the price has fallen very low. He will rather wait patiently in the hope that the price will soon rise again; because, under such circumstances, the greater number of cultivators become disgusted with the production of the plant in question. It is thus that the great variations in the price and cultivation of hops, madder, and woad have arisen in several countries in which the production of these plants had been naturalized; it was entirely abandoned when prices fell low, and was not resumed until the favourable moment for reaping the greatest advantage from it had already passed.

The cultivator whose operations are conducted on a large scale should choose from among the vegetables of this class, and especially from such as are used in his own country, those in particular which, by a proper division of labour and the use of suitable implements, can be cultivated without much expenditure of manual labour; for where mere labour is concerned, he will rarely be able to compete with the small cultivator, who executes such operations assiduously with the help of his family. The latter, content with a small profit, offers his produce at a low price, so that it is the merchant and not the cultivator who is enriched by it.

We are fully disposed to admit that the production of vegetables for the market is the highest aim that an enlightened agriculturist should have in view, since this branch of husbandry is really more profitable than any other; but we are also of opinion that he should not devote himself to it without considerable caution, but take it up by degrees, and assure himself beforehand of a plentiful and continual supply of manure.

I have thought it my duty to define, by the observations just concluded, the true limits between the seductive praises which some persons have lavished on this branch of agriculture, and the discouraging objections of others.

OIL-PLANTS.

The plants most commonly cultivated for the production of oil, belong to the genus *brassica*. This race of plants has, in the course of cultivation to which it has been submitted from time immemorial, undergone such remarkable modifications, and produced so many varieties or degeneracies, that there is considerable difficulty in distinguishing and separating its different species; viz., those which have acquired a certain permanence of character; and still more in investigating their origin, and determining by what crossings they have been produced. We shall here notice only those varieties which are cultivated in preference to others for the production of oil; though, in fact, all plants of this genus produce seeds containing considerable quantities of oil, and are sometimes used for obtaining it.

All plants of this family appear to be biennials; so that it is not till the second year of their existence that they shoot forth their flower-stalks and produce seed. One species only appears to form an exception to this rule, viz., the spring colza or field-cabbage (*brassica campestris*). This plant is not, as some suppose, a degenerate variety of autumnal rape, or coleseed, but really a distinct species.

Colza and Rape (Autumnal Varieties).

We shall first notice the plants of this kind which are sown in autumn. There are two essentially distinct species cultivated; they are, however, often confounded, both in name and in mode of cultivation; but it is of importance to the cultivator to be well acquainted with their differences.

One is the *brassica oleacea laciniata*, a variety of the garden cabbage. It is commonly known by the name of *colza*, or *large colza*, from the German word "*kohl-saat*," signifying cabbage-seed.

The other kind which is called "*rape*," is a variety of the *brassica napus*. It is more common in Germany than the former, because it may be sown later, and thrives on a less fertile soil; moreover, many persons cultivate it because they are unacquainted with colza, which they would otherwise find more profitable and less precarious. To enable the practical cultivator to distinguish readily between these plants, I shall here exhibit their distinguishing characters side by side.

COLZA. (*Brassica Campestris.*)	RAPE. (*Brassica Napus.*)
(*a*). Belongs to the cabbage tribe, and resembles the plants of this family in all its characters.	(*a*). Belongs to the radish tribe, and bears a greater resemblance to the plants of that family.
(*b*). Principal root cylindrical.	(*b*). Principal roots fusiform, closely resembling that of the radish: when the plant has room to spread, it sometimes produces a true radish.
(*c*). Leaves smooth, fleshy, bright, green, sometimes (especially the lower ones) copper-coloured, and covered with a whitish down.	(*c*). Leaves hairy, thinner, less rounded at their extremities.
(*d*). Stem strong, giving out no branches from its lower part; but, above a certain height, throwing out branches which spread more in the horizontal than in the vertical direction.	(*d*). Stem not so strong, throwing out from its lower part branches which form an acute angle with it.
(*e*). Flowers, bright yellow, come out and ripen late.	(*e*). Flowers deeper yellow, come out and ripen earlier.
(*f*). Siliquas and seeds large.	(*f*). Silaquas and seeds smaller.
(*g*). Requires early sowing, that it may take root well.	(*g*). May be sown later.
(*h*). Under these circumstances, it is strong, and stands the winter well.	(*h*). More delicate, and easily destroyed by the winter.

It is not uncommon to find these two plants confounded and mixed together, and, in countries where both are cultivated, to meet with a hybrid variety, at least I think I have seen it. This intermingling of the two species is altogether improper, especially on account of the difference in their seasons of maturity; no pains should therefore be spared to procure the seed of one species or the other unmixed.

In countries where these plants are much cultivated, they are both included under the denomination of autumnal plant-seed, or simply, plant-seed, a circumstance which has given rise to frequent misunderstandings between cultivators both in those countries and in others.

These two plants may be perfectly well cultivated on all soils which are proper for wheat and barley, but chiefly on those containing from 50 to 60 per cent. of sand, together with a small quantity of lime.

A condition absolutely necessary for the success of these plants is, that the soil be completely purified and drained; for dampness in winter is always fatal to them. When this condition is fulfilled, colza will also thrive on the light but rich soils of alluvial basins, especially when it is sown early in the season and enabled to take firm root. But rape absolutely requires a soil having some degree of consistence; on a lighter soil, it is easily uprooted by frost.

A very rich soil is required for colza, more even than for rape: these plants must, therefore, be raised on a soil which is either naturally fertile, or has received more than double the ordinary quantity of manure. It is also necessary that the manure be easily soluble; and, consequently, that the stable dung be in a somewhat advanced state of fermentation, and well mixed with the soil. It is often the practice to manure the land with dung, bury the dung by one of the early ploughings, and then, before sowing, to turn the sheep into the field.

It is equally necessary that the soil be well cultivated and pulverized. The plough and the harrow must be used at least four times; and in the ploughings which immediately precede the sowing, the roller is also brought into use for the purpose of minutely dividing the vegetable soil. In general, therefore, the cultivation of these plants extends over two years; and the rent of the land during all that time must be placed to their account. It is true that we not unfrequently see rape (with colza the method would utterly fail,) sown on the stubble of rye, after the land has been hastily manured and ploughed two or three times. But this method generally produces but a very poor crop, not amounting to more than half the usual quantity; and besides this, the soil is terribly exposed to become infested with weeds. I have seen very good lands, which had been treated in this manner at short intervals, become deteriorated and exhausted to such a degree, that it was not till after several fallowings that a satisfactory crop of wheat was again obtained from them. Every cultivator, whose views are ever so little extended, should beware of adopting so ill-advised a method.

Better results have been obtained by raising two successive crops of these plants on the same land; devoting the interval between harvest and seed-time to a careful cultivation of the soil, and manuring it well, if it be not already in a state of great fertility.*

When a field of clover has been well covered, we may yet obtain a crop from it in the sowing year, provided we mow early, so as to be able to plough the land three times more. But the soil must be thoroughly cleansed from dog's grass. The land may also be made available for raising a crop of tares, to be mown in the green state; provided it be ploughed once before sowing the tares, and twice after they are gathered.

The usual time for sowing colza is from the middle of July to the middle of August; it may, however, be safely sown at an earlier part of the season, for it never produces seed the first year. The time for sowing rape is from the middle of August to the beginning of September.

The sowing should take place as soon as possible after the ploughing intended as a preparation for it. As soon, therefore, as this ploughing is finished, the ground should be harrowed for the purpose of levelling it, and afterwards rolled. The seed is then to be put into the ground, the harrow passed lightly over it, and also the roller, if the soil be dry. If, however, a heavy rain should fall, either during or immediately after the sowing, there will be no necessity either for harrowing or rolling, since the seed will then be sufficiently covered without these

* Vide "Thaers Vermischte Schriften," 1er Band. S. 486, A.

operations. If the soil should be much clotted by the rain, it will be useful to pass the harrow lightly over it before the seed comes up.

It is particularly important that the seed be uniformly distributed over the land. The best plan is not to use more than five pounds of seed per acre, and to sow it in such a manner as not to leave any vacant spaces; for when the plants are very close together, they retard one another's growth, become weakened during winter, and die; but when they are further apart, they become strong, and able to resist the injurious effects of particular states of the atmosphere. Even when plants unequally sown are able to live through the winter, those which are too close together are, notwithstanding, stunted in their growth, and rarely capable of ripening their seed. For colza it is therefore of great importance to employ a skilful sower; if we hear of one living at any distance, we ought by no means hesitate about engaging him, and paying him a ducat per day if he demand it. A bad sower may cause the crop to fail. If we cannot depend on the skill of the sower, it is better to sow eight pound of seed per acre.

The land should be provided with good ditches and drainage furrows, for carrying off the water. In winter, during a thaw, all possible care must be taken to keep the drains clear.

If, towards the end of summer, a great number of weeds, particularly of the wild mustard tribe, should spring up amongst a crop of early sown colza, they should be cut whilst in flower: even if the leaves of the colza should be cut at the same time, the plants will not be injured. In this manner, a considerable quantity of fodder may be derived in autumn from a field of colza.

If a field sown with colza enter upon the winter in good condition, the plants being healthy, of a deep green colour, neither too crowded nor too far apart, and, lastly, if the arrangements for draining and carrying off the water have been judiciously made, there is every reason to hope for a good crop; still, however, there is something to be apprehended from the critical period at the end of winter. A continued alternation of thaw and frost uproots the plants and kills them. The melting of ice and snow under the rays of the sun, and the frost which follows in the night, are dangerous to all crops which grow during winter; and the more so in proportion as the upper layer of the soil is more saturated with water, which is unable to pass off through the lower stratum, because that stratum is frozen. Under all these circumstances, it is possible that the seedlings may be destroyed, even though they have been sown with the utmost care.

Besides the plant-louse, which attacks it immediately after seed-time, colza is also subject to the ravages of other enemies, viz., the mouse, the weevil (which lays its eggs in the flower, whence there springs a worm that feeds upon the seed vessels), and the glow-worm (*nitidula ænea*). It is said that these insects multiply with peculiar rapidity in districts where the cultivation of plants of this kind has been long practised.

Such are the ordinary principles of the culture of rape and colza; for these plants do not differ in any respect excepting those already pointed out. But in the Netherlands, and the countries bordering on the Rhine, and likewise in some parts of England, the practice of transplanting has been long established, particularly with regard to colza. Wherever the value of a fertile soil is great in comparison with the price of labour, this method appears to be almost universally followed; because it admits of a great part of the land being made available even during the year in which the transplanting takes place, and, at the same time, affords an opportunity for executing the necessary ploughings. Various descriptions have been given of this method, but the most accurate is that of Schwertz, in his excellent work on Flemish agriculture.

Transplanting is performed either after ploughing, or with the spade or dibber. As I cannot speak of this method from my own knowledge, I must refer my readers to the work of Schwertz; which will, doubtless, be in the hands of every cultivator who wishes to adopt the method.

On the other hand, a method which Schwertz describes as very successful in his own hands, viz., that of drilling in rows, separated by considerable intervals, is one with which I have long been practically familiar, and which I shall probably always adopt in sowing colza for seed. I trace furrows with the marking-plough, two feet apart, and sow the colza with the radish-drill. This operation is performed on a well prepared soil; the tracing out of the rows being preceded by one more cultivation with the extirpator and levelling with the harrow. I have never tried Schwertz's method of sowing colza in this manner on a soil on which a crop of ripe grain had been gathered the same year; but I have done it after a single cutting of clover, or after tares mown in the green state. After seed-time, the roller is passed over the ground.

When the plants have put forth their fourth leaves, the horse-rake, armed with three horizontal knives, is passed between the rows; and if the plants are sufficiently advanced, they are earthed up with the horse-hoe after Michaelmas-day. If wild mustard and charlock make their appearance between the rows, they are pulled up; it is rarely that the crop is infested with any other weeds. I have never found it necessary to earth up twice before winter; such a proceeding might, however, be useful.

The earth laid up against the rows prevents the colza from being uprooted by frost; for the trenches formed by laying up the earth, completely protect the plants from moisture, provided the field have ditches, in good condition for carrying off the water. When this arrangement is observed, I do not think that there is any thing to be feared from the winter.

In the spring, as soon as the plants begin to shoot forth, the earth is again laid up.

There is ample time for putting in the seed; viz., from the beginning of July to the middle of August. The land must be kept in readiness, and the seed sown during rainy weather, in order that the plants may shoot up quickly, and be safe from the attacks of plant-lice. However distant the rows may appear, the plants spread out their branches so widely, that the field will always be well covered by them.

The season of maturity of these vegetables, which is usually the middle of June, should be carefully attended to. We must not wait till all the seed-vessels are ripe. As soon as those which ripen the earliest begin to turn brown and transparent, and the seeds to acquire a blackish-brown hue, the crop should be gathered without delay; for if the gathering be delayed, the plants will shed a great portion of their seed.

There are various modes of gathering this crop.

When the seed has been sown broadcast, the scythe may be used; but it must be without rods or cradles. The crop is heaped up, lifted, and made up into bundles at once. All these operations are easily performed, and without much loss of seed; but where the sickle is in use, reaping is preferred. When the weather is dry, both these operations are best performed early in the morning; or even at night, when the moon shines and the dew is on the ground.

There are two ways of harvesting this crop. One consists in housing it in barns; the other, in threshing it on the field. If the former method be adopted, it is usual to tie up the crop in bundles not exceeding 10 lbs. in weight; and for this purpose the several portions are collected, not with the rake, but by hand. This is usually done the day after mowing, or on the following day at the latest. The sheaves are then collected in heaps, of greater or less magnitude; large heaps are, however, preferred, because the seed is then less in danger of dropping from the pods and being devoured by birds. If the sheaves are left on the ground for any considerable time, they are covered with straw. Even if rain should fall, and continue for some time, the sheaves are, nevertheless, suffered to remain without being turned; for the seed is not injured, even though the straw should become heated and give out a peculiar odour. But it would be liable to shed if the sheaves were disturbed.

The crop is usually housed after five or six days. The waggon used for carrying it must be provided with large sheets or cloths, to collect the seed which falls from the sheaves. These sheets are fastened to the ladders in such a manner as to have their edges raised.

If the seed be disposed to drop from the pods, a large sheet or cloth is also placed before the heap every time that the waggon is loaded, and one side of the waggon is made to pass over it, so that all the seed which falls may be collected. The loading is performed with great care, and in such a manner that the sheaves may project but very little beyond the ladders; and the waggon is drawn by two horses only, though the team is usually composed of four.

The crop is shot upon the threshing-floor, unless there be in the barn a space boarded and perfectly clean on which it may be deposited.

This crop is usually threshed as soon as possible, in order that it may not interfere with operations at harvest time, and likewise because the grain is more easily separated at an early period than after the straw has sweated; the straw is also preserved in better condition.

The grain is separated from the chaff by winnowing, and the larger pods by means of a coarse sieve. The finer part of the chaff remains for a time mixed with the grain, and is not separated till the latter is perfectly dry; the separation is then effected by means of a fanning machine.

Care is taken to spread the grain so that the thickness of the layer shall not exceed four inches, and at first to stir it often with the rake.

The other method is much practised in districts where colza has for a long time been cultivated on extensive tracts of land. In Marshall's "Description of the Agriculture of Yorkshire," vol. ii. page 103, there is a very excellent description of the ordinary mode of threshing colza. I have seen this mode of threshing established in the same manner, attended with the same practices, and likewise regarded as a general festival, in the provostship of Preez and Kiel: it is also practised in the Western part of the low countries bordering on the Baltic. But, if an individual cultivator adopt this method, the treading out of the grain by horses will certainly be found advantageous: this method is described by Kaehler, who has extracted it from the diary of a journey which he made in Holstein. This description is found in a work entitled "Handbuch für Landwirthe." In order to make this method known to such of my readers as are not in possession of this work, I cannot do better than transcribe the author's account. It is as follows:—

"At nine in the morning, the proprietor, M. Niemeyer, had the kindness to go with me to the colza-field. I was struck with astonishment at sight of the immense space of ground covered with the plant; a great part of the rop was extended on the stubble: but another, and much larger portion which had been mowed, was collected in little heaps of 6 or 7 feet in height.

"Everything was in full activity: the colza was being carried, and at the same time, trodden out by horses on the field. Sledges drawn by two horses were used for carrying and collecting the colza. On each sledge was placed a hand-barrow, with two rods crossing in the middle, and having a large cloth, from 32 to 36 square feet in surface, stretched over them. Three similar sledges followed one another in a line. One of these files was at work near the colza, which was lying on the ground in breadths. Four women were employed in loading the sledges: they lifted the colza with a stick about three feet in length, which they held in the right hand; and while they kept it in equilibrium with the left hand, the whole was placed on the cloth without the least effort. Whenever a loaded sledge moved off, there was an empty one ready to take its place, and everything went on without interruption.

"We arrived at the heaps. Here also was a file of sledges employed in carrying the crop, the operation of loading going on much more quickly than in the former case. Two men were at hand, with levers, from 8 to 10 feet in length, and very light, ready to lift the parcels of various sizes on to the large cloth. This part of the work went on with great rapidity. One man took hold of the levers, and introduced them between the ground and the heaps; while another, stationed on the opposite side, was in readiness to seize the levers as soon as he could see them; and thus the whole heap was placed on the sledge.

"We next passed on to the floors on which the crop was threshed: there were two of these floors placed at some distance apart. The ground had previously been prepared by removing the stubble and stones which might be collected on it. These floors were quadrangular, each of them being 48 feet in length, and 36 in breadth, and covered with strong cloths. These cloths were raised at the sides to the height of a few feet above the ground, and attached to feet fixed for the purpose. The entrance was on one side, and there the cloth could be lowered 5 or 6 feet.

"To each file of sledges were attached two men employed in unloading. This operation was also quickly executed; for, as soon as a sledge arrived, the handles of the barrow were seized by two men, one in front and the other behind, who removed the whole to the floor, turned it over, replacing the barrow and the large cloth on the sledge as soon as they had unloaded it. In this manner the operation was continued till the floor was covered with colza to the thickness of about 6 feet.

"The entrance was then cleared, and two attendants, each leading three horses, entered and mounted on the layer of colza. They led the horses four or five times round the floor, and then re-descended. The colza, thus trodden out, was then immediately turned over by several men armed with forks, and then the horses were led over it again. After they had again made a few turns, the operation was finished, and the men who had turned the colza removed the straw from the floor.

"It appeared to be scarcely possible that so trifling an amount of labour should suffice to separate the colza completely from the straw; but a careful examination soon convinced me that it was so, for I found scarcely a grain left amongst it.

"The straw, having been completely removed, the coarsest part of the residue of the stems and seed-vessels which remained in contact with the grain was collected with the rake towards one corner of the large cloth. At this angle was placed a board three or four feet long and several feet broad. It was fixed obliquely, and in such a manner that its top projected beyond the edge of the cloth. The coarser part of the chaff was drawn along with the rake, and fell beyond the floor, clear from the seed far more effectually than could possibly have been expected.

"The loading, turning, and raking being finished on one floor, the horses were led on to the other, and *vice versa*, so that the whole of the process was constantly going on.

"As this part of the work proceeded, the colza was conveyed by the team to the repositories, where it was deposited on the floors of the barn; and although the distance was very short, the team was scarcely equal to the work.

"Thence we proceeded to the repositories, where the operation of cleansing the colza was in progress. A barn of great width and length, with two floors boarded lengthwise, and one in the middle boarded across, was completely covered with colza. Ten labourers were employed in winnowing the colza, after a number of women had passed it through a sieve to separate the coarser portion of the chaff; and whilst one set of men were employed in carrying the cleansed colza to the granary, after it had been arranged in separate heaps, others were engaged in unloading the waggon which brought the grain from the field, and depositing it in heaps of considerable length, but moderate height.

"The grain is left untouched in these heaps for about twenty-four hours; during that time it becomes slightly heated, and acquires a fine black tinge.

"I was overwhelmed with surprise at seeing so large a quantity of colza in the granary. The preceding year's crop still remained there almost entire; and as a year's crop amounts to about 1,500 tons, the quantity then collected must have amounted to 3,000 tons.

"This is all that my journal contains. Every one must surely approve of this mode of gathering a crop of colza. The work goes on with great rapidity, which is a great desideratum at a time so closely bordering on harvest. But the subject must be regarded in another point of view. Everything is done in the open air, and therefore absolutely requires a continuance of fine weather. Should rain set in, it might perhaps be advisable to take advantage of occasional fine days, to get in as much as possible of the crop. The cultivator must, therefore, exercise his own judgment upon this point, and take such measures as will enable him, either in fine or in wet weather, to make choice of the method which he thinks most conducive to his interest and most in accordance with existing circumstances."

Schwertz (vol. ii. p. 178) proposes as a new method, invented by himself, but not yet introduced, to stack the colza as soon as it is cut, and let it ripen in that situation. But this method is neither new nor wonderful: it was described some time ago by Reichard, and is adopted in several rural establishments in Westphalia. Reichard proposed to cover the stacks with boards and load them with stones, in order to make the temperature of the colza rise still higher. This, however, is useless.

The grain is not injured by this treatment, but ripens without dropping from the pods. The straw is, however, deteriorated when the stack becomes heated. The stacking is begun by placing five or six sheaves tied together in an upright position, and side by side; a bundle of straw being laid under them. The bundles are then placed all around, and carefully arranged, with the pods turned inwards and the stems outwards. The stacks, when completed, are covered with straw, more to keep off the birds than to protect the grain from moisture; and in this manner they are left till the time arrives for threshing, which is usually performed in the field during fine weather.

Colza and rape are not absolutely exempt from casualties. The former is, however, less exposed to them than the latter, provided it be sown early. According to my own experience, the method of drilling protects it from the dangers of winter; the only remaining danger is from insects.

When colza and rape are cultivated in the ordinary way, their produce varies from five to twelve bushels per acre. On a rich soil, colza yields more than rape. By the method of drilling, Schwertz has obtained as much as fourteen bushels; and according to trials which I have myself made, this quantity is by no means extraordinary. Such a crop must not, however, be expected every year. The price of colza and rape is subject to great variations. It has sometimes risen higher than 6 rix-dollars per bushel, and I have never known it lower than 2½; four rix-dollars may be considered as the average price. Even when maritime commerce is stopped, the home consumption of oil is sufficiently great to keep up the price of colza, because at such times there is a scarcity of whale oil. The price never suffers any considerable diminution, excepting after a very abundant whale or herring fishery. Colza always fetches more than rape, because its produce in oil is 10 per cent. greater.

The cultivator who raises these plants on a large scale is much more likely to gain by them if he keeps his own oil-mill; because by so doing he not only makes himself independent of merchants and oil-manufacturers, but also preserves the cakes, which afford most useful nourishment for the cattle. Where oil-plants are cultivated in large quantities, an oil-press will repay its cost at a very high interest.

The straw of these plants is not of great value; but when housed in good condition, it deserves higher estimation than is given to it by those who only seek to get rid of it, and burn it for the sake of spreading its ashes on the land, thereby confining its utility to the very spot on which it is spread. Sheep are very fond of the husks and the ends of the branches; the remainder may be advantageously mixed with the dung.

That these plants exhaust the soil to a very great extent, and do not in any case restore to it the manure which they require and absorb, is a fact respecting which no doubt can exist: all impartial persons who cultivate these plants in large quantities will agree to it, whatever may be said by cultivators who are obstinately prejudiced in favour of this branch of cultivation. Even when, as is often the practice in England and Belgium, the cakes are *directly* given to the soil as manure, the nutritious matters absorbed by the crop are not fully restored: and, moreover, a German cultivator would not easily make up his mind to deprive the cattle of this kind of food. The raising of these plants in very large quantities exhausts the land to such an extent as to render necessary the utter abandonment of this cultivation, when it has been engaged in by those who neither have the means of procuring a supply of manure from without, nor possess a sufficient quantity on their own establishments. Those who maintain the contrary rest their assertion on the fine crops of autumn-grain which are usually obtained after the cultivation of these plants. But it must be remembered that, as a preparation for this cultivation, it is usual to give the land double the ordinary quantity of manure, to bestow the greatest pains on the preparatory fallowing, and after harvest to plough up the land again with the greatest care. These plants may doubtless be regarded as an intermediate crop, which serves to keep the soil light, and fertilize it by the shade which their leaves afford. It is not, therefore, surprising that the succeeding crop should always be very abundant, since the soil retains a sufficient quantity of nutritive matter; and this matter has been brought within the reach of the crop which immediately follows. But after this crop fresh manure is almost indispensable, for the success of those which follow; unless, indeed, the soil be naturally possessed of uncommon fertility. When, therefore, colza and rape are to be raised in large quantities, it is necessary to bear in mind the considerations already noticed respecting the cultivation of vegetables for the market in general.

But colza may also be made very useful as a fodder-plant, and in this capacity contribute as much to the welfare of the establishment in general, as to the fertility of the soil in particular. It is true that a rich soil is required for this purpose; otherwise, the colza does not grow to a sufficient height. When colza is to be raised as a fodder-plant, it may be sown in and after the month of May; and, according to the early time of the sowing, and the more or less favourable state of the weather, we may obtain two, three, or even four plentiful green-crops from it, even in the seed-year itself. It will often shoot forth early in the spring, affording the first supply of green food for the cattle. The plant may, if desired, even be allowed to run to seed; it will still yield a complete crop. If, in consequence of the soil not being sufficiently fertile, the colza should not shoot forth in the first year with sufficient vigour to furnish plentiful green crops, it will at all events afford excellent pasturage for the cattle: it is eaten with avidity by animals of all kinds, and soon shoots forth again after having been fed off. In England, colza is more frequently sown as a pasture-plant, than for seed: and this mode of employing the land is considered as equivalent to a plentiful manuring. Fields are there met with which are never manured, but treated in this manner every four or five years.

Clover thrives perfectly well among colza, whether the latter be allowed to ripen, or whether it be mowed or fed off. Moreover, if colza be always used as green food, it is a good plan to devote a certain number of fields entirely to the raising of fodder for a few years; a mode of proceeding which is farther recommended by the low price of the seed of this plant.

Rape is not well adapted for fodder; and spring-colza, which grows up and flowers quickly, is altogether unfit for that purpose. Some persons by mistake have used it in this manner; but they have obtained a very poor crop, and only one supply of green food.

Many plants bearing some affinity to colza have been cultivated in its place: the Swedish turnip, or rutabaga, has been lately brought into notice as superior to it, both in quality and quantity of seed. This opinion has been promulgated, particularly in France and Germany, by Schwertz. The seed of colza was doubtless originally derived from the plant with the fleshy root, to which this name is applied: but by growing in fields where it has been crowded, and its root has not been able to attain its natural size, the nature of the plant has at length been so far modified that at present the same seed no longer gives rise to a root of considerable thickness, even when the plant is isolated. I have for some time remarked that the Swedish turnip yields an enormous quantity of seed, and that the seed is very rich in oil. The great advantages which Schwertz and Clémens have derived from it, and the superiority over colza which they assign to it, have strengthened my own conviction, and determined me to lose no time in giving the preference to the Swedish turnip in my own cultivation.

SPRING COLZA, OR SPRING RAPE.

These two names are applied indifferently to the same plant; and this plant is totally distinct from both colza and rape. It is not, like various kinds of spring and autumn wheat, a mere variety obtained by cultivation: it is the *Brassica campestris* of botanists, the same that grows wild in many places, and in that state is commonly known by the name of wild cabbage. It is the only plant of this family which possesses the property of growing up and flowering rapidly, like mustard and wild-radish. It is, therefore, a spring-plant, which may be sown from the time when all danger of frost is over, to the end of June, without any risk of its not attaining maturity.

This plant thrives in a soil which is fertile, rich, and not very dry: it requires careful ploughings to clear the land from weeds. In the three-field system, it is usually sown on the fallow; and, after the harvest, succeeded by a crop of some autumnal grain. This plant does not absorb the nutritive principles of the soil so much as colza: it, however, consumes a large quantity of them in proportion to the time for which it occupies the ground, and commonly yields much less abundantly than the oil-plants which are sown in autumn.

The soil being prepared, the seed must be sown when the weather is fine, but rather damp, in order that it may germinate and spring up quickly, and thus more easily escape the injurious effects of weeds and the attacks of plant-lice. The success of the plant depends both on the weather, and on the absence of scarabs and their larvæ; and likewise of certain black caterpillars, which often attack it at the time of flowering. Spring-colza ripens about Michaelmas; that which is sown early ripens sooner. It requires for the most part the same labour as autumnal colza, excepting that it is rarely threshed in the open field.

A prudent cultivator will lose no time in ploughing up the crop, as soon as he perceives that it is likely to fail: otherwise the weeds will choke it, and infest the soil.

We cannot in general reckon on a produce of more than five bushels. It is only on the soil of drained swamps that a greater product is obtained; and in such situations the crop sometimes equals that of autumn-colza: for these soils it is therefore a very advantageous crop, on account of the rapidity of its growth.

The seed is also less valuable, because it yields a smaller quantity of oil. It is only when perfectly ripe that it yields as much as 18 or 20 lbs. of oil per bushel. Many persons, however, raise this plant in preference to the autumnal oil-plants, because it occupies the ground for one summer only.

It is said to be not uncommon, in the Bishopric of Paderborn, to meet with spring and autumn colza sown and mixed together: in such cases, the former is gathered in the year in which it has been sown, and the latter in the following year: this is certainly a curious method.

MUSTARD.

This plant has lately been recommended as an advantageous substitute for spring-colza, to be used in the production of oil.

There are two distinct species of mustard, differing from one another not only by their colour, but also by other external characters.

White mustard produces siliquas rough to the touch, and terminated by a long point or horn. The colour of its seed is yellow, inclining to brown. That which is called English mustard, is nothing more than a variety produced by cultivation.

Black mustard has a smooth siliqua, which adheres firmly to the tongue. In Germany this species is preferred for making mustard for the table: its husks are more easily opened than those of white mustard.

Both species yield oil which is well-adapted for burning; and also, when well purified, for the use of the table. A quintal of mustard-seed yields from 36 to 38 lbs. of oil.

The biting acridity of the seed exists not in the oil, but in the integument; and the English mustard, which is celebrated for its strength, is said to be made from cakes from which the oil has been expressed.

Mustard is said to thrive better than spring-colza on poor soils, and to be less sensible to cold. It may, therefore, be more advantageously sown at the end of winter: this proceeding is even necessary, for mustard is particularly liable to be destroyed by plant-lice. It suffers in a less degree from scarabs and worms. It continues for a long time in flower, and affords excellent nourishment for bees: its siliquas are formed successively. For cutting mustard, especially the black species, it is necessary to choose the exact time when the first siliquas are ripe.

The produce of mustard is, on the average, greater than that of spring-colza. The most advantageous mode of disposing of it is, perhaps, to sell it to those who prepare mustard for the table, provided that circumstances will admit of this course. It is, however, more profitable than spring-colza for the preparation of oil, because it yields a greater quantity. It therefore deserves the preference in every respect, excepting perhaps that it requires to be sown earlier, and therefore imposes the necessity of greater expedition in giving the necessary preparation to the soil.

The cakes which form the residue in the preparation of the oil are said to afford a mild and stimulating purgative for cattle, and in this capacity to be very useful: they are ground and spread upon the fodder given to the cattle.

OILY RADISH (RAPHANUS CHINENSIS OLEIFERUS.)

This is a variety of the common radish; it has been strongly recommended on account of the simplicity of its culture, the abundance of its produce in seed, and the large quantity of oil which it yields: it is, however, nowhere cultivated for any great length of time.

It shoots up vigorously in height, and spreads out its long branches with considerable force: it therefore stands in need of support. It cannot easily be kept upright, excepting on narrow beds surrounded with sticks placed horizontally at a certain distance from the ground. Its seed-vessels are very liable to be attacked by the larvæ of the weevil. They ripen very irregularly, because the plant flowers continuously; and sometimes the greater number of them do not ripen before winter. If this plant could be sown in autumn, and would withstand the winter, as it appears to do according to experiments made by some persons, it might probably be cultivated at less risk: but it does not seem well-adapted for cultivation on a large scale in the open field.

Its produce is, to all appearance, extraordinarily large; indeed, when particular plants are separately considered, it appears to exceed that of any other oil-plant. It will multiply ten-thousand fold, and is, therefore, an excellent plant for those whose main object is a very great multiplication of seed. But the plant when isolated spreads to such an extent that it must be considered doubtful whether, in proportion to the space of ground which it covers, its produce in grain is equivalent to that of other oil plants. The seed is said to yield 50 per cent. of its weight of oil; and the oil possesses an agreeable flavour.

CULTIVATED GOLD OF PLEASURE (MYAGRUM SATIVUM.)

This plant also grows wild, and is sometimes very troublesome amongst flax: it grows to the height of one or two feet. The stem is angular, hairy, and branching: the leaves are lanceolate, and embrace the stem at their bases: the flowers are yellow, and grow in large clusters at the top of the stem. The siliquas are obovate, flattened, and terminated by the persistent filiform style.

The plant delights in sandy soils, provided they are rich; and it is on such soils that it is cultivated: but it exhausts them to a great degree.

It is sown in April, and gathered about the end of July, or the beginning of August. It is less subject than other oil plants to the ravages of insects, and seldom fails entirely. Its produce scarcely exceeds 5 bushels per acre. A bushel ought to yield from 20 to 24 lbs. of an oil, which has a slightly bitter taste, and thickens with cold.

COMMON POPPY (PAPAVER SOMNIFERUM.)

Several varieties of this plant are cultivated: they are distinguished from one another by the colour of their flowers and seeds, and the structure of their capsules.

The colour of the flower is unimportant. The seed is either white or black. Some persons think that the black-seeded variety is the more productive; others give the preference to the white in this respect. The white seed is the more agreeable to the taste, as is likewise the oil expressed from it. That variety of poppy is preferred whose heads or capsules when ripe assume a slightly blush tinge.

The structure of the capsules is of more consequence;

for there is a variety in which the envelope of the capsules dehisces spontaneously when ripe, so that the seed is easily shed: and another in which the seed remains enclosed within the capsules, which must be opened in order to extract it. The former is well-adapted for cultivation on small pieces of ground, where the heads may be cut off and put into bags as they ripen; but it is quite unfit for cultivation on a large extent of surface, where it is desirable to gather the whole crop at once.

The poppy requires a rich soil, containing a large quantity of humus, and well prepared for its cultivation. When it is to be raised in the fields, the soil selected for it must be of the best quality, the most completely manured, the cleanest that can be found, and, if possible, somewhat sheltered from winds. It must be one which has been prepared and manured the year before, because poppies thrive better the sooner they are sown.

It is a favourite plan to sow them in March, even on ground covered with snow, provided the covering be of uniform thickness. This method is said to be wonderfully successful.

Poppies are sown very thinly. To insure the proper spreading of the seed, the operation must be intrusted to a man well practised in thin sowing, as gardeners are. A pound of seed is too much for an acre. If, however, the plants be subsequently thinned, no injury will result from their having been sown too thickly at first.*

The operation of thinning the poppies and pulling up weeds which grow amongst them, is absolutely necessary to their complete success. The spaces between the plants should not be less than six inches; and if the soil be very fertile and tolerably well sheltered from winds, the produce will undoubtedly be greater when the plants are even twelve inches apart. When poppies are too crowded, they produce but small capsules, containing very little seed, and that too of inferior quality. The

* The poppy cannot be transplanted: it would be useless to endeavour to fill up the vacant spaces by this method; even in weeding it while young, great care must be taken to avoid injuring its roots.

operation of thinning is performed much more easily, and with far greater benefit to the plants, by the use of a mattock or hand-hoe, than by pulling up the weeds and superfluous plants by hand; at least, if the labourers are accustomed to this kind of work; for, by the former method, the earth is at the same time lightened, and, to a certain extent, heaped up round the plants.

This cultivation with the hoe, or the pulling up of weeds, must be repeated, if it has not been properly performed the first time, or if the weeds again make their appearance.

Poppies are often sown amongst carrots; and as the carrots have still two months to grow after the poppies have been torn up, this method doubtless tends to make the land yield as much as possible. But it interferes with the full effect of the hoe-cultivation just spoken of, and likewise with the regular thinning of the poppies and carrots—a condition which must nevertheless be fulfilled, if we wish to obtain the best crop that the land can yield.

It is necessary to take advantage of the precise time when the poppies are ripe. Now, this is the very season when the harvest-labours are in full operation, a circumstance which renders the culture of the poppy very difficult in large rural establishments. If, however, the poppies ripen all at once, which may be effected by sowing early and taking care to thin them well, the labour of gathering is not very great. The crop must not be suffered to stand too long, as it will then be attacked by rooks, sparrows, and mice. The mice gnaw the plant close to the ground till the stem falls, and the capsules are thus brought within their reach. Neither must the fruit be gathered before it is ripe, for the seed will then have a bitter and disgusting flavour, and the oil will not be fully developed. The stems are cut close to the ground; or, if the soil be light, the plants are pulled up. They are then tied up in bundles with straw placed round them close to the capsules, and housed as quickly as possible. The lower parts of the stem are cut away as far as possible, and the bundles deposited in a well-covered and well-aired situation till they are thoroughly dried.

The poppy-heads are then opened separately by hand, and emptied by turning them over and shaking them. If there are no feeble old men or children on the establishment, this operation is very troublesome, for it must be performed precisely at the time when there is the greatest quantity and variety of work to be done. Poppies raised in large quantities are usually threshed* to separate the seed from the capsules; or else the capsules are cut open with a machine, and the seed is separated by winnowing, or by the use of the sieve, or the fanning machine.

When the seed has been cleansed, it is conveyed to a granary which has a very close grating; or, if there be no such accommodation at hand, it is spread on a large cloth. At first, it is frequently stirred, and afterwards, when quite dry, put into casks, in which it is kept.

The poppy may become one of the most profitable crops if we have the means of disposing of the seed, or if we know how to extract the oil. By proper cultivation it may be made to produce from nine to ten bushels of seed per acre, and one bushel yields 24 lbs. of good oil. This oil, especially the first portion, which is cold-pressed and mixed in the mill with slices of apple, is doubtless the purest kind of oil for the table, and the most agreeable that is known. It is inferior to none, excepting, perhaps, the finest Nice or Lucca oil. It is preferable to the second-rate oils of those places, and the peculiar taste of olive-oil may be imparted to it by the addition of a small quantity of that oil of superfine quality. But the seed may often be sold in its natural state, and we can readily obtain a Frederick-d'or per bushel for it. But notwithstanding this large return, the

* The operation of bruising and pulverizing the capsules a little, is apt to leave a small quantity of their substance, which is bitter and narcotic, amongst the seed. It is, therefore, essential to the goodness of the oil, that the seed be taken out of the capsules by hand, and then passed through a sieve fine enough to cleanse it perfectly.—FRENCH TRANS.

cultivation of the poppy is in some establishments attended with so many difficulties, that the great cultivator ought to think more than once before he undertakes it.

There are other plants whose seed may be used for the production of oil, but respecting which this mode of application is but a secondary consideration. Of this number are flax, hemp, and tobacco, of which we shall presently treat. There are others again which are cultivated in gardens only, such as the sun-flower (*helianthus annuus*): these I content myself with mentioning. Their seed certainly produces a good table-oil, and the return from it may be considerable; but the gathering and preservation of them in granaries are attended with so many difficulties, that they cannot be recommended to the cultivator, but must be left to the province of the gardener, who may sometimes raise them to advantage amongst his other produce; for these plants always thrive better when isolated, than when crowded together in the field.

The cultivation of gourds has also been recommended for the sake of their seed, which indeed produces an oil of very agreeable flavour, though small in quantity; but the raising of them must, for the most part, be left to the gardener.

I shall also merely allude to the wild mustards, charlocks, and radishes, which no cultivator would purposely raise, but which are too often found in abundance on his land; and may, if carefully separated, be used for the production of oil.

THREAD PLANTS.—FLAX.

The culture of flax and the manipulation of its thread, are treated in full detail, not only in agricultural manuals and treatises, but also in various essays written expressly on the subject; and the directions given in these works are, according to the various degrees of merit of their authors, sufficiently exact to render it superfluous for me to enter at length into the consideration of this matter.

Moreover, the manipulation of flax and the preparation of the thread are sufficiently well known to all practical cultivators, and all details relating to the latter of these objects are more easily and effectually learned by inspection, than by the perusal of written directions. After the seed has been sown, the remainder of the work belongs to the women's province, and may be most advantageously entrusted to them: they usually take very great interest in the success of the crop. I shall, therefore, confine my observations to one or two principal points, which, in my opinion, have either not been treated so clearly and fully as they deserve; or, on the other hand, appear to be yet involved in doubt.

Opinions are much divided respecting the advantages which may accrue either to the great or the small cultivator, from extending the culture of flax. If one person sees in it, and with reason, an interesting branch of industry, another, on the contrary, regards it, not without reason, as a leading cause of the decline of agricultural prosperity.

It is certain that flax absorbs in a peculiar manner the old nutritive particles remaining in the soil; that it requires long and tedious cultivation; and that, too, at a time when there is a superabundance of work to be executed; and, consequently, that it may cause the neglect of some operation of particular importance to the welfare of the establishment in general. It follows, therefore, that in places where the old system of cultivation is pursued, where economy is necessary, with regard either to the quantity of manure and the nutritive matter contained in the soil, or to the amount of manual labour and the employment of time in summer, on account of the thinness of population, it is impossible that advantage can result from any great extension of the culture of flax. But on a soil which has been fertilized by repeated ameliorations, and in establishments in which abundance of manure is produced, and there are plenty of hands, especially women, the cultivation of flax may be undertaken without inconvenience.

In countries where spinning and weaving form the principal resource of the people during winter, it is particularly advantageous to give this kind of produce the preference before other marketable plants. In such countries one often has the opportunity of selling the crop as it stands, and thus clearing a considerable net profit, without the trouble of gathering and subsequent treatment. It may be a good speculation to establish spinning rooms and looms on an estate, for the sake of conveniently employing during winter a number of labourers, who may afterwards be occupied for the summer season in agricultural operations. In this manner we may increase the number of well disposed people about us, and also the population in general. Under such circumstances, it is, doubtless, advantageous to extend the culture of flax and the preparation of the thread: and, what is more, this extension may be made without inconvenience. But if these two circumstances do not exist, the culture of many other marketable plants seems to me to be preferable to that of flax: the latter should, I think, be then restricted within such limits as are prescribed by the wants of the establishment itself.

Flax prefers a light soil mixed with sand, to a strong clayey soil. It is, however, necessary that the deficiency of power to retain moisture which results from the composition of the soil, be made up by its situation. It is, moreover, essential that the soil be rich and fertile, either by nature, or from having previously received an abundant supply of manure. The want of this fertility cannot well be supplied by manuring the land at the time of sowing. The soil must not, however, be immoderately rich; for the flax would then be very likely to be laid. A light, marly soil agrees with it better than any other.

In countries where the three-field system is practised, it is almost always the custom either to sow flax on the fallow-field, or to substitute it for fallowing. This place appears to me the most inconvenient that could possibly be assigned to the plant. It is difficult, especially in raising fast-growing flax, to give the land that complete cultivation which ought to precede the sowing; especially when the soil has become greatly infested with weeds from the raising of several successive crops. Flax is regarded as a bad preparation for autumn grain; and every practical cultivator reckons on a sensible diminution in the produce of grain which is immediately to follow a crop of flax. In the three-field system, I should much prefer to put the flax on the spring-corn field, which may much more easily be prepared in the manner required, especially if the fallow preceding the autumn grain has been carefully attended to. If this fallow field has been plentifully manured, it ought to possess considerable fertility. In that case, especially after the autumn grain has been removed, it would be necessary to clear off the stubble superficially, or simply give a half-ploughing, and afterwards in autumn to plough deeply. If the soil appeared to require fresh manure, I should have a quantity of perfectly fresh stable dung carted on to it during winter, and spread over the surface, after the harrow had been passed over it. The dung would remain in this state till dry weather in spring would allow me to have the straw raked, or, as would be more convenient on large surfaces, to have it collected in little heaps, by means of a large harvest-rake drawn by a horse; the remainder would then be taken away, to be used for other purposes. The land would thus obtain the nourishment required for the crop of flax, without being too much raised by the straw. Instead of this, it may, doubtless, be advantageous to turn the sheep on to the field. The plants will then vegetate powerfully: but, above all, the soil will be rendered very porous, and, after one ploughing, will be well prepared for the reception of the seed. Peas will thrive well on land which has borne flax in the preceding year; and the autumn grain which follows the peas will succeed better than it would if sown immediately after the flax. This, however, supposes that it has not been thought preferable to sow clover among the flax; a plan by which clover succeeds better than by any other, unless, perhaps, amongst buck-wheat.

But flax is also perfectly successful when sown after clover on a single ploughing, especially if the clover be biennial. The stubble of the clover is ploughed up either in spring or autumn, with some care, and not too superficially; and then the harrow and roller are passed over the ground. Before sowing flax, the harrow with projecting teeth is forcibly passed over the surface; or else (and this is the better method) the extirpator is used. The flax is covered with the harrow, and the roller passed over the surface. The mode of manuring just described may be here adopted if the flax be thought to require it; but a slight manuring with lime, soap-boiler's ashes, or the dung of fowls, especially pigeons, scattered at random, will be found more beneficial.

On the other hand, according to the observations of the Belgians, flax does not succeed after legumes, especially peas. It is perfectly successful after weeded crops which have been well manured; it is also cultivated with advantage after hemp: but hemp must not be sown after flax.

Flax never thrives better than on a rich and fertile clearing, or land which has for a long time been laid down to grass. I think it would be difficult to find a more profitable mode of employing such land for the first year of its return to cultivation. It must be scarified more or less deeply, according to the thickness of the layer of turf: the latter must be carefully turned over; and for this purpose, the fork or the spade must be used in places where the plough is insufficient. This operation should be performed in autumn, or in early spring; and the ground harrowed and rolled immediately afterwards, to prevent the grass from coming up between the furrows. At seed-time the ground is strongly harrowed, then the seed is put in and buried with the harrow, after which the roller is passed over the surface. I have never seen flax growing more vigorously and firmly, or with longer stem, than on a clearing of this description: a further advantage is that the ground does not require weeding. At most, it is only the roots of a few weeds which are hardy and difficult to destroy, that shoot up again; and these are easily pulled up. The turf under flax becomes so light and porous that a single ploughing is sufficient for the winter grain. On a clearing, the soil of which was rich and fertile, I have in this manner obtained a very good crop of wheat after one of flax. I was induced to give the preference to this first grain, from the circumstance of a crop of rye having been laid the year before, when sown after flax which had been grown on a clearing. I know of no crop under which close turf becomes more friable.

When I have no clearings, I cultivate flax exclusively in hollows situated in the fields devoted to the autumn grain, where I should otherwise fear that the water would remain during the whole winter, or where this inconvenience has actually been experienced. If the extent of these hollows is but small, I go to the expense of having them cultivated with the spade; and a short time before sowing, I manure them with a mixture of compost and lime, which, together with the seed, I bury with the harrow. In this manner I obtain as much flax as I want, and even more, without devoting useful land to it; and, at the same time, I keep in cultivation portions of land which would otherwise become acid, and produce rushes and other marsh plants.

Flax must not be grown again till after a considerable interval, on land which has once borne it. It is thought that a space of at least nine years ought to intervene between two crops of this plant, even in countries where the soil appears best adapted for its cultivation, and where that cultivation is most successfully carried on—as for example, in Belgium.

It has been laid down as an essential condition for ensuring the success of flax, that the seed must be renewed every three, or, at all events, every four years, by procuring Riga flax-seed, which grows in Livonia, Courland, and Lithuania. Experience has shown beyond a doubt that our hemp-seed becomes gradually bastardised, and produces, year by year, plants which grow to a less height, and, especially, branch out too soon. We are, therefore, obliged from time to time to purchase this costly seed at the price of from 18 to 22 rix-dollars per tun of two bushels; whilst we ourselves sell it for only 3 or 4 rix-dollars. As to our flax-seed, it is neither the climate nor the soil that occasions its deterioration, but rather the scanty attention bestowed upon the crop. We do not allow the seed to ripen, but separate it too soon from the stalks; and, consequently, we cannot prevent it from being somewhat burnt, and changing its colour from a yellowish tinge to brown. In the countries bordering on the Baltic, where the sale of this seed constitutes an important branch of commerce, it is treated with great care. The flax intended for seed is sown much more thinly than that which is designed for other purposes; and the soil chosen for it is mostly a clearing, from the surface of which the turf has been peeled off: the flax is allowed to ripen completely, the fineness of the thread being sacrificed to the quality of the seed: the seed-bearing branches are then cut to the length of a span, and wound in a spiral direction round a rod. The rod is then straightened, and the flax-seed left till it becomes perfectly ripe and dry; after which it is threshed. By this process the seed is made to preserve its yellow colour, its lustre, and the agreeable odour which is peculiar to it: in this state it produces more vigorous plants. It is certain that by following the same process we might obtain flax-seed quite as good as that which we get from abroad, and thus save the high price which we are obliged to give for it. Experience shows the utility of keeping flax-seed for two years; according to some persons, it continually improves by keeping.

There are two sorts of flax: one bearing seed-vessels, which burst with a report, when, after ripening, they are powerfully dried by the sun's rays: its thread is fine, short, and pliant. And another, which requires threshing to separate the seed. In Germany, the latter variety alone is cultivated, the former not being considered profitable. The distinction of early, medium, and late flax, depends entirely on the time of sowing; for the seed is otherwise the same. The early and medium varieties appear in general to be the safest. In many parts, however, it is only the late flax that is sown, merely because it is not ready for gathering till after harvest; and it is desirable not to be hindered at harvest-time.

I say nothing about the remaining processes in the preparation of flax, because they are sufficiently well-known, and I should merely have to repeat that which has been said a hundred times over. I must, however, notice the contradictory opinions which have been advanced respecting the comparative advantages of *dew-rotting*, and *steeping* or *watering*. The former method is the safer of the two; but it takes up a great deal of time, especially in dry weather. In the dry summer of 1810, this method was impracticable: it then became absolutely necessary either to steep the flax, or, at all events, to sprinkle it frequently with water. The process of steeping is very expeditious, but it requires great care and attention to prevent the thread from being injured. It is not in all situations that a sufficiency of water can be obtained for this operation; it fills the air with putrid effluvia, and the water with decomposing vegetable matter, which destroys the fish. Then again, it must always be performed by women, who are usually unwilling to depart from established practices. It is, therefore, better to adhere to the mode of management already established in the country.

In separating the seed, the cultivator takes care to divide it into seed of the first quality, which he keeps for sowing; seed of medium quality, to be used for the extraction of oil; and inferior seed, which may be most advantageously consumed as food for the cattle.

Perennial flax (*Linum perenne*) which is a totally distinct species, has been strongly recommended by some persons, and seems in fact to be decidedly superior in one respect, viz., that it lasts for several years (I have myself kept it growing for six years in full vigour), and produces much longer and firmer stems; but its thread is coarse, brown, and not easily separated: hence, this species of flax has never continued long in favour with any one.

Hemp (*Cannabis Sativa.*)

Hemp is one of those plants in which the sexes are separated. A remarkable variety of this plant is that of Alsace or Strasburgh, the stem of which grows to the height of eight feet.* This great length of stem is probably the result of that careful cultivation doubtless bestowed on those plants which are raised for the sake of their seed, and of the abundant room which they have for growing. When the plant attains this height, it is much exposed to injury from high winds. It is not yet decided whether this variety would thrive in the climate of the north-east of Germany.

For hemp, even more than for flax, the soil must be rich in humus, moist by its situation, and, at the same time, light and moveable. Drained marshes not containing peat, and muddy ponds from which the water has been allowed to run off, are very well adapted for the culture of this plant, which yields, when grown upon them, a very plentiful crop. It is only on the rich lands of low countries that hemp will thrive on the whole extent of the fields. On high grounds its produce is not great, unless a large quantity of manure be bestowed upon it; or, as already mentioned, it be confined to certain low patches of ground more fertile than the generality of the land: hence the cultivation of hemp is absolutely unknown in some countries. On a well-adapted soil, hemp may be raised for many years successively on the same spot.

If the soil be not naturally light, it will often be necessary to prepare it for this crop by four successive deep ploughings.

* I have myself measured stems of this plant growing on my own land both in Bologna, and at Romagna, in Italy, which stood above-ground as high as 15 ft. 8 in. Rhine-measure. A friend of mine has measured some that were 18 ft. 6 in. Rhine-measure in length; and, nevertheless, the thread of these plants was remarkably beautiful.

On damp soils, the dung of sheep and horses is most beneficial to hemp, on account of the heat which it affords: but when this plant is grown on a dry soil, it requires a considerable quantity of well fermented cow-dung.

Hemp is sown from the middle of April to the end of May* on land recently ploughed. The quantity of seed is 1 or 1½ bushel per acre, accordingly as coarse or fine hemp is to be raised. Damp weather is preferred for seed-time, and the seed is buried with the harrow. The last year's hemp-seed is considered better than that which is older, and the seed is never changed.

Hemp springs up quickly, and grows very rapidly; hence, it very soon covers the whole of the ground, and chokes the weeds, so that it rarely becomes necessary to pull them up or hoe the crop. This is one great advantage of the cultivation of hemp as compared with that of flax. The greater broom-rape (*orobanche major*) and the branched broom-rape (*orobanche ramosa*) are the only weeds which infest hemp: they may sometimes entirely destroy it. They are not found anywhere else.

The male hemp is *pulled up*† as soon as it has discharged its pollen, and begins to turn yellow at the top. This change usually takes place at the end of July, or the beginning of August,‡ and, therefore, during the most pressing occupations of harvest. This circumstance greatly increases the difficulty of cultivating hemp, for the operation takes up a great deal of time. Hemp pulled up at this time produces the finest thread, and, consequently, it is a pity not to gather it at that time; besides the female plants which are left standing, have then more room to grow and gain strength, and therefore yield a larger quantity of seed.

* As soon as all danger of frost is thought to be over. I have seldom or never seen hemp injured by white frosts happening after it has come up. I should recommend that it be always sown as soon as all fear of frosts, properly so called, is past.

† It is much better, or rather absolutely necessary to reap it, in order to obtain a fine thread; for that afforded by the root is coarse and bad.—French Trans.

‡ In Italy, about a month after the wheat harvest.—French Trans.

The remaining part of the gathering and preparation of hemp, is for the most similar to the corresponding part of the treatment of flax. There are, however, different methods of conducting these processes, descriptions of which may be found in various manuals of agriculture and essays specially devoted to the subject; particularly in Kähler's admirable "Handbuch für Landwirthe."

The raising of hemp in large quantities cannot be recommended to a cultivator whose land is of very great extent, unless he has particular pieces of ground peculiarly adapted for raising this plant; and either a sufficient number of hands for gathering and preparing the crop, or the means of selling it on the ground. Hemp is everywhere an object of primary necessity for the manufacture of cordage:* it yields abundance of seed; and as it is very rich in oil, the disposal of it may be regarded as certain.

In rural establishments which have only now and then portions of land fit for the culture of hemp, such, for example, as ponds which have been drained, it is proper to provide in the course of one year a supply of this plant which shall suffice for several years after. I have often obtained as much as forty or fifty rix-dollars net profit per acre, although the expenses of cultivation were higher than they ought to have been.

OTHER PLANTS, THE CULTURE OF WHICH HAS BEEN PROPOSED FOR THE SAKE OF THEIR THREAD OR COTTON.

Syrian Swallow Wort, or Virginian Silk (*Asclepias Syriaca*).

In the years 1790-1800, this plant was loudly vaunted as capable of supplying the place of cotton, and its produce was brought into use at several manufactories, especially at Leibnitz. Since that time, however, we have heard nothing of it, although circumstances have been very favourable to the production of any plant that

* In countries where much rain falls in the summer season.—FRENCH TRANS.

could supply the place of cotton; we may, therefore, be allowed to suppose that it has not fulfilled the expectations which were entertained of it. Nevertheless, its cultivation is extremely easy, and it thrives well in the most arid soils, provided they are enriched with a little manure.

Common Nettle (*Urtica Dioica*).

Of late years the cultivation of this plant, both as food for cattle, and for its thread, has again been strongly recommended. It may be multiplied either by seed or by the transplantation of roots and stocks; and it is said to possess the peculiar advantage of succeeding on the worst soils—on sand-hills, among stones, and in other places where the ground could not be used for any other purpose. This assertion seemed to me rather astounding, because I had never seen the nettle grow to any considerable height, excepting in situations in which there was plenty of humus; but my doubts were removed upon finding it stated, in the midst of a magnificent eulogium of the nettle, that it is necessary to put a few inches of good mould on the places where this plant is to be raised.

The cultivation of the nettle, either as a thread or fodder plant, may then be safely recommended to those who have no better means of employing their good vegetable soil, and the labour which they have at their command.

There have also been recommended as thread-plants various species of mallow, the Spanish broom (*spartium junceum*), the common broom (*spartium scoparium*), the rosebay willow-herb (*epilobium angustifolium*), the stem of the hop, &c. On this subject I refer my readers to the work entitled "Herzers vollständige Geschichte der Benutzung vieler bisher noch unbenutzter deutscher Woll und Seeden-gewächse." Regensburg, 1794. Meanwhile we shall content ourselves with the culture of hemp and flax.

Fuller's Teasel (*Depsacus Fullorum*).

This plant must here be introduced on account of its great utility to the woollen manufacturers, who are so anxious to obtain it, that in many localities its cultivation may be very profitable.

The teasel grows wild in Germany; but the wild teasel cannot be used for raising the nap of cloth, because the prickles with which its head is armed have not the crooked points which they acquire by cultivation.

It is sown in spring. In the first year the plants do not grow to any height. They are usually transplanted in July to the distance of a foot or two. In the following year they put forth stems from four to six feet in height. The flowers appear at the extremities of the stem and branches, forming ovoïdal-heads, armed with long elastic prickles, between which the purple flowers show themselves. When all the flowers are blown, the heads are cut off, leaving about a foot of the stem. They are then dried in a well-aired barn, and tied up in bundles of about a hundred each.

The remarks already made on the culture of marketable plants in general, are equally applicable to the teasel.

COLOURING PLANTS.

Dyers' Madder (*Rubia Tincterum*).

The plant is a native of the south of Europe; but it is capable of withstanding a more northern clime.

Its roots, which are used in dyeing, are about as thick as a goose-quill, and often two or three feet long; they are composed of portions united by a kind of articulation, round which numerous filaments are given off. They contain a fleshy substance, which is of a deep red colour without, and pale red within. Towards their upper parts they throw out lateral roots, which extend horizontally under ground, and produce new shoots in spring. The haulm dies on the approach of winter. The stems are several feet high; they bear ovate, or rather lanceolate leaves arranged in a whorl. The flowers are yellow, and supported by peduncles united at their bases in the form of a bouquet.

This plant may be reproduced by seed; but the propagation may be more rapidly effected by planting shoots which are thrown up from the root in spring. It must be observed, however, that plants, which for some generations have been propagated in this manner, lose their inclination to produce seed. Some cultivators think it useful to renew, from time to time, the production of madder from seed.

Madder requires a light, humid soil, ameliorated by repeated manurings, and recently dunged.

The soil is turned up either by the use of the spade alone, or partly with the spade and partly with the plough; or if the plough alone be used, it is made to go as deeply as possible.

The plants are sown in rows two feet apart. After every third or fourth row, a double space is left. When the plants are grown up, the mould is removed with a shovel from this last-mentioned space and spread out amongst the plants, so that the field then presents the appearance of raised beds, separated by deep furrows.

The planting usually takes place in May; and, as the plants do not grow much the first year, many cultivators avail themselves of this interval for sowing other vegetables on the land.

On the arrival of winter, the beds are covered with dung; which is again removed with the rake at the beginning of spring, and superficially buried in the furrow.

The plants then put forth vigorously; the hollow spaces or furrows are carefully lightened with the hoe, and cleared of weeds. In the spring of the third year, the intervals are again hollowed out, and the mould thus withdrawn from them, which has been enriched by the remainder of the dung put upon the beds in the autumn of the first year, is again spread out among the plants. This operation is performed in the same manner as upon asparagus beds.

The roots are gathered before winter. Some cultivators pull them up in the second year; but this is allowable only when the soil is uncommonly rich, and even then the roots do not attain the size or quality of those which have been in the ground for three years, and hence they are not easily disposed of.

Such is the method which, with some modifications, is usually followed in the cultivation of madder.

Some time ago I recommended to several cultivators of madder the method proposed by Schwertz, in the second volume of his "Agriculture of Belgium," page 213, and they applied it with great success; but neither Schwertz nor myself can be regarded as the inventor of this method, which had been previously recommended by a clergyman named Christ, in his "Unterricht von der Landwerthschaft," Frankfort am Main, 1781. His words are (p. 464), "When we consider the advantages presented by the method of Tull, we shall immediately see that there is no plant to which that method is more readily applicable than to madder." I cannot, however, help thinking that it is dangerous in a first cultivation to remove the mould near the rows, according to Tull's method.

If I were to cultivate madder, I should proceed as follows:—The soil having been perfectly prepared and cleared, I should make furrows with the double mould-board plough at intervals of three feet, and set the plants on the summit of the ridgelet formed in this manner with the earth turned over by the plough. When the plants had grown to a certain height, I should again pass the plough along the furrows, after having separated the two mould-boards to a somewhat greater distance. The plough then penetrating to a greater depth, would convey to the plants the mould which it raised out of the furrow. This operation I should repeat once more. Before winter, if the soil were not naturally very fertile, I should spread all over the surface a quantity of dung somewhat fermented; some of which would certainly fall into the furrows. In the following year I should again pass the same plough along the furrows, so as to bury the dung, and again earth up the plants. This method would not entirely save manual labour, but would, at least, diminish it to a considerable extent. It would be necessary to hoe and scarify between the rows; and these operations heaping up the earth in the furrows, the plough would again throw it upon the beds. In the third year, if the furrows were broad and the plants sufficiently grown, the further cultivation of the soil might be performed with the scarifier or horse-rake.

No one who has observed the effect of this mode of culture on other plants, will doubt that its success will be as great as that which Christ promises and Schwertz announces. It has the advantage of greatly facilitating the gathering of the roots, which, according to Schwertz's observations, being all in the same direction, may easily be taken up by the plough.

Madder should be exposed in a well-aired but shady situation to dry it. The best mode is to spread it upon hurdles as in a tile-kiln.

Its final preparation is not the business of the cultivator, unless he is at the same time a manufacturer. If he is not sure of a market for his madder when dried, and before it is bruised, he should not cultivate it unless he has a mill to grind it in.

Whoever wishes to plant madder in large quantities, ought to have seed-beds of his own. It would be too costly to purchase the necessary quantity of plants.

However advantageous the cultivation of madder may be when properly organized, it is necessary, before undertaking it, to consider maturely all that has been said on the culture of marketable plants in general. The culture of this plant is practicable only where there is a *superabundance* of manure. Moreover, it cannot enter into any ordinary rotation, on account of the length of time during which the crop remains in the ground; viz., for three years, or two at the least.

Dyer's Woad (*Isatis Tinctoria*).

The culture of this plant was at one time very common in Germany, especially in Thuringia: in the thirteenth century it was principally cultivated in the environs of Erfurt. It then formed a very considerable branch of commerce, and was a source of prosperity to many provinces and towns. But in the middle of the sixteenth century indigo was introduced from the East Indies; and in the seventeenth century its use became extended, and supplanted that of woad. The evil which ensued soon became apparent, and pecuniary pains and penalties were enacted against the use of this *devil's colour*, as indigo was called. But these measures of commercial policy shared the fate of all similar proceedings—they increased the evil. Manufacturers and dyers declared that they could not exist without the use of indigo; and that a pound of the latter yielded as much colour as three quintals of woad. So bad a character was given to woad, that dyers became ashamed to use it, and pretended to make use of nothing but indigo; although it is said that they employed woad in secret. From that time the culture of woad has become rare, and confined to particular localities.

But now that we are again obliged to make use of woad, cultivators are beginning to pay great attention to it; and it is probable that the art of preparing from this plant an indigo equal to that of the East will be realized and generally diffused. In that case, the culture of woad may again become profitable; always, however, under the conditions which we have laid down as binding on the culture of marketable plants.

There are two varieties of the plant called *dyer's woad*; one cultivated in Germany, and the other in Languedoc. The latter is said to be greatly superior to the former, and also capable of succeeding in Germany.*

* See the work called: "Entdeckung der in Deutschland noch unbekannten ächten zahmen Wardpflanze, nebst Nachricht über den Unterschied dieser und der Thüringschen (Von Otto)."—Frankfort, 1794. A.

The stem of woad grows to the height of three feet, or three and a-half feet; it is about as thick as a finger, and divides into several branches clothed with leaves. The leaves of the stem are amplexical, sagittate, pointed, slightly crenate, and tinged with blue. The flowers are yellow, and grow at the top of the stem.

Woad requires a good soil, either naturally fertile or well supplied with manure; carefully cultivated, and in good condition. The seed is sown in spring, or more advantageously in autumn, about the end of August or the beginning of September. The quantity is about four or five metzen per acre. Woad sown in autumn suffers occasionally, though not often, from the effects of winter; but its produce is much greater than that of woad sown in spring. If the plants shoot up considerably in the autumn, they are mowed; and the crop so obtained is used as fodder for cattle. In the spring it is necessary not only to destroy weeds by hoeing, but also to thin the plants in the rows, so that they may be at least a foot apart.

A great saving both of labour and of seed would be obtained by drilling and cultivating with the horse-rake.

When the leaves are about a span long, and the flowers ready to burst, the stem is cut off close to the root, and the largest leaves are stripped off. Some weeks after this, new leaves are put forth, and these are gathered in the same manner. This operation is repeated as long as the plant continues to grow. In this manner four crops are often obtained from autumn-sown woad. Some persons content themselves with three crops, in order to allow the leaves time to grow to a larger size. On a good soil, the average produce is about 150 quintals of leaves, weighed in the green state.

The portions of the plants thus gathered are washed; and as quickly as possible exposed to the sun till they are dried, or rather merely withered. It is then immediately transferred to the woad-mill, a trough in which a wheel, armed with teeth either of wood or iron, turns round and crushes the woad. When the trituration is completed, the woad thus ground is formed into heaps in the open air, and covered up to keep it from the rain. A week or twelve days afterwards the heaps are uncovered, the woad broken up, and the interior of the heap mixed with the crust formed on the outside. The woad is then made up into balls, which are usually placed to dry on hurdles, exposed to the wind but not to the sun. The balls, when dry, are ready for sale. Such is the common process; but a better might, doubtless, be devised.

A circumstance connected with the cultivation of this plant, which will always alarm the cultivator, is that he is obliged to undertake the manufacture as well as the culture. Now this operation must necessarily be performed immediately after gathering, while the leaves are yet fresh, and at a time when in all rural establishments there is plenty of work for all hands.*

Dyer's Weld (*Reseda Luteola*).

This colouring-plant presents to the cultivator the great advantage of being saleable without any other preparation than drying.

It thrives best on a sandy soil, inclining to the argillaceous character, highly manured, well cultivated and weeded. The seed, which is small, should be sown in August, in quantity about eight pounds per acre: it will not bear to be covered with a large quantity of earth. In the month of August of the following year, the seed ripens, and the plant begins to turn yellow; it is then pulled up, dried, and tied up in bundles, which are sold by the quintal. The seed may also be used for extracting oil.

The culture of weld requires but few details; and as an acre produces from six to eight quintals, each of which may frequently be sold for eight rix-dollars, the crop is very profitable, provided we have the means of disposing

* "Vom Anbau des Wardkrautes dessen Zubereitung und Anleitung Indigo daraus zu machen."—Vien. 1788. Schreber's "historische-physische und œconomische Beschreibung des Waides."—Halle, 1752.

of it. Marshall, however, advises those who let land to farmers, to introduce a clause into the lease, prohibiting the culture of this plant, because it is very exhausting to the soil.

Bastard Saffron (*Carthamus Tinctorius*).

This plant requires a soil in a state of cultivation equal to that of garden ground. The seed is sown early, at intervals of two feet; several grains being, however, sown together, in order that those plants which present the best appearance may be afterwards left to grow, and the rest pulled up. The interspaces are kept free from weeds by cultivations, for which the horse-hoe is the most appropriate implement. When the flowers turn yellow, or assume a somewhat darker hue, which they do in August, they are plucked with a blunt knife, and afterwards dried under cover. This operation of plucking the flowers should be performed in the forenoon, and never during the hottest part of the day. The gathering takes up more time than any other part of the culture of this plant.

The plant is left standing till it ripens; it is then pulled up, dried, and threshed for the purpose of separating the seed. This seed yields a good oil, but only in small quantity.*

THE HOP.

This kind of produce is become an object of almost primary necessity: its sale may always be regarded as certain, and the price which it fetches is sufficient to pay the interest of any sum that may have been expended on its cultivation, at the rate of cent. per cent. The culture of the hop ought, therefore, to engage the attention of every cultivator who is able to advance the necessary capital, and has brought his system of rural economy to such a degree of perfection as to furnish him with the

* Dallinger's "Œkonomisch technologische Abhandlung über den Safler und Waidbau."—Neue Auflage, 1805.

very large quantity of manure which this cultivation requires.

There are two species of the hop; the wild and the cultivated. The former is in every respect smaller and weaker than the latter; and though it might be improved by cultivation, no one thinks of making the trial, because the cultivated hop is always easily procured. Of this latter species there are two varieties, the early and the late; the panicles of the former are larger and more aromatic than those of the latter. On the other hand, the latter produces a greater number of panicles, and is said to be much less liable to diseases and casualties. In general, however, all well informed cultivators give the preference to the early variety, especially those who can usually obtain the requisite number of labourers for gathering it when ripe; that is to say, towards the end of harvest time, at the end of August or the beginning of September.

Less careful cultivators are in the habit of mixing the two species indiscriminately in the same garden: a practice which is mischievous in every respect, and greatly interferes with the gathering of the crop. In planting a hop-ground, especial care should, therefore, be taken to prevent the mixture of the two species.

The hop is a diœcious plant; that is to say, its male and female flowers grow upon different stocks. The plants, have, however, almost the appearance of undergoing a change of sex; for the females being alone available for use, are likewise the only ones from which shoots are taken. The males are always destroyed, except when the seed is intended to ripen. A few male plants may, however, always be found in hop plantations: their existence is not easily accounted for, except upon the supposition that some of the plants have ripened their seed before the usual time.

The spot chosen for the hop-ground should be in an open situation, but somewhat sheltered from the north wind. Hop-grounds, which have not a free circulation of air, are precarious. The best mode of enclosing the ground is to surround it with a ditch: a hedge may, for greater security, be planted by the side, but it must be kept low. Very dusty situations, such as the neighbourhood of great roads, should be avoided.

The soils best adapted to the cultivation of the hop, are clayey sands and sandy clays, provided that they are in a proper state of fertility at the time of planting, and are afterwards supplied with the quantity of manure required for continuing and increasing their fertility. On moist, argillaceous, and heavy soils, the success of the plant is more precarious; but on the other hand, its produce is greater when it does succeed. Where the lower stratum of the soil is mixed with calcareous stones, but the vegetable stratum is of considerable thickness, the hop is sure to thrive well. Fertile soils, which have been long used as grass-lands, kitchen-gardens, or orchards, and have always been plentifully dunged, are the best that can be chosen for the formation of hop-grounds.

When a piece of land is to be prepared for growing hops, it is a good plan to cultivate a hoed crop on it the year before, unless we intend to plough it often and carefully during summer. Even if the land has been manured for the hoed crop with eight four-horse waggon loads of stable-manure per acre, it will still be necessary, after gathering that crop, to manure again with at least ten waggon-loads per acre: this latter quantity may be either spread over the surface and left there, or buried with the plough. At the beginning of spring, as soon as the soil is somewhat dried, it must be turned up to a considerable depth, either with the plough or the spade.

The hillocks on which the plants are to grow, should be at least four feet square: some persons place them six or eight feet apart. A pole is set up in the place which each of these hillocks is to occupy; a circular trench, four inches wide and five deep, is dug around it at the distance of six inches, and the plants are set on it in such a manner as to leave from three to five of their eyes above ground. Strong and healthy plants must be selected for the purpose. The trench is then filled up with the mould taken out of it, care being taken to press the earth close to the plants, and form a little mound of earth round them, so that the buds may be completely covered. At the end of a few weeks, sooner or later, according to the state of the weather, the young plants will begin to grow. As soon as weeds make their appearance, the whole ground must be hoed, and the spaces between the plants weeded. This is the time for fixing the poles which are set in holes previously made for them with an iron fore-stake. To these poles the young plants are tied; only, however, the principal shoots; the others are cut off. The former soon begin to climb up the poles, twisting themselves round in a spiral direction. If necessary, the false shoots are again cut off.

If, instead of forming the plantation with young plants which have just taken root, we make use of grown plants taken from an old hop-ground, the planting may be deferred till autumn. A tolerably good crop will then, in all probability, be obtained in the following year.

The hop is earthed up on St. John's day, the mould being taken from the interstices and a little hillock formed round each pole. In performing this operation, particular care must be taken not to touch the roots of the hop. As the produce is very trifling in the first year, many cultivators plant other vegetables, such as cabbages and beet root, in the interstices. The first year's crop is, indeed, so inconsiderable, that many persons abandon it altogether, and cut off the tops of the plants to strengthen them.

The hillocks are manured after this first crop; five large waggon-loads of dung per acre are used for this purpose. The earth forming the hillocks is depressed a little, and the dung then placed upon it. In March, the portion of dung remaining on the hillocks is removed, and buried in the intervals: the poles are also restored to their places. The quantity of dung must be regulated according to the wants of the soil: an excess of it might induce disease in the plants. The superabundant germs, which in spring form a very agreeable dish, are removed. Six or seven stems only are allowed to shoot up, and are again tied to the poles; in other respects the mode of proceeding is the same as that of the preceding year.

The principal difficulty which some cultivators have to contend with, is that of procuring poles. These poles must be from fourteen to eighteen feet long at the least; for the first year, however, shorter ones may be used.

Some persons set up two or three poles on each hillock, and distribute among them the stems of the plants which grow upon it. The cost of the poles forms the principal part of the expense of forming a hop-ground; and various methods have been devised for reducing it. Thus, it has been recommended to make the hop climb round poplars with their heads lopped, as vines grow in some parts of Italy. Hops will certainly be obtained by this method, but the crop will be inferior both in quantity and quality; moreover, the plants will be more subject to disease; so that the cultivation of the hop by this method will not, in the end, be more profitable than when poles are used. The trellis work which has been proposed as substitute for poles, is likewise not more advantageous.

As soon as the hop is ripe, which may be known by its assuming a brownish tinge, becoming hard and firm, and acquiring a pleasant aromatic odour, the gathering should be commenced without delay. The early hop is usually gathered about the beginning of September; and the late, towards the end. The stems are cut close to the ground, and carried away with the hops which grow upon them. The picking is performed either on the ground-or under cover. The former method requires dry weather; and in order to profit by such weather, the greatest possible number of labourers must be employed. The poles are placed, two at a time, on a kind of scaffolding, and under them is hung a cloth to collect the hops as they are picked. The work-people occupied in picking the hops, chiefly women and children, are scattered round the scaffolding; whilst others, at the same time, bring new poles, and remove those which have been picked. When the cloth is full, the hops are thrown into a large sack, in which they are carried to the drying place. If they were left in the sacks they would soon become heated.

If the hop is to be dried within doors, the poles are drawn out of the bundles of hop plants which enclose them; the plants are then tied lightly together and carried under cover, where they are picked as quickly as possible. The former method is doubtless to be preferred, when a sufficient number of hands can be obtained; for hops which are housed before they are picked, are apt to acquire a bad taste.

The hops, when picked, should be spread out in a thin layer on the floor of an airy barn, and turned every day till they are perfectly dry; or they may be placed on a stove which is well set and burns without smoke. The latter method is the more expeditious, guards against all loss, and is beneficial to the hops. The stove is covered with a horse-hair cloth, on which the hops are placed in a layer, varying in thickness from six to twelve inches, according to their greater or less degree of moisture and ripeness. The heat of the stove must be well regulated, constant care being taken not to keep it too high. When the peduncles of the hop break with facility, and the follicles fall off, the drying is complete; eight or ten hours are required for bringing the hops to this state. This mode of drying doubtless requires some experience and practice to enable the person who conducts it to adopt and maintain the exact temperature required. It is indispensable to keep a man constantly engaged in this work. The hops having been thus dried, are carried to a room prepared for them, and there left for six or seven days, in order that they may regain a small quantity of moisture before they are packed up.

After the hops have been dried by either of these methods, the cultivator either has them carried to the warehouse intended for keeping them, and there packed closely by treading them under foot; or they are put into bags for sale.

In order to bag the hops, the mouth of the bag is attached to a frame, and a handful of hops is attached to each of its lower corners to give greater hold. The hops are then put into the bag by degrees, and pressed closely, either with the feet, or with a heavy pestle. When the bag is full it is detached from the frame, a handful of hops is attached to each of the upper in the same manner as to the lower corners, and the mouth sown up with pack-thread. The quantity put into the bag may vary from 150 to 200 lbs. Hops packed in this manner will keep for a long time; whereas, if they are left unpacked, they will lose their glutinous surface and aroma.

The quality of the hop is judged of according to the glutinous character of its surface, its aromatic odour, the farinaceous substance with which it is speckled, and its colour, which should be a bright yellow.

As soon as the gathering is over, the poles must be taken care of by placing them under cover, or tying them up in bundles, 30 or 40 together, and leaving them in the open air.

The produce and value of hops are very variable. The best hop-ground sometimes yields scarcely a quintal per acre; whilst in other seasons, it will produce from fifteen to eighteen quintals. The price sometimes falls to 12 rix-dollars per quintal; at other times, rises to 70 or 80 rix-dollars. Hops yield a very large profit when kept from a year of plenty to one of scarcity: but this is the business of the speculator, rather than the cultivator.

The expenses of cultivation are no less difficult to estimate; for they depend upon the locality: nothing, therefore, can be said with regard to the average net profit and advantages of this branch of cultivation. Particular cases are known in which the net profit per acre has amounted to two or three hundred rix-dollars in a year; whilst, in other cases, the receipts have been far from sufficient to meet the expenditure.

In fact, the success of the hop is mainly dependant on the weather, and the absence of certain accidents to which the plant is exposed. The care bestowed on the formation and culture of the hop-ground may indeed obviate casualties to a certain extent, but cannot utterly remove them. A warm summer, with moderate winds from the south and south-west, and not much rain, is favourable to the hop: but, in wet seasons, particularly when the wind blows much in summer from the east and north, the hop is sure to fail. When a hot sun follows rain or fog, or sultry days alternate with cold nights, the hop suffers considerably, even when these occurrences take place only at the latter end of the summer. In spring, the hop suffers from the attacks of an insect of the flea kind; in summer, from various kinds of flies and lice, but especially from *honey-dew*, which, at this time, shows itself after cold nights, and attracts insects: nothing but a heavy thunder-shower can save the hop from these enemies. In the last stage of its growth it is exposed to mould and honey-dew, especially when the hop-ground is in a low and confined situation. In the midst of all the dangers and enemies with which the hop is surrounded, its success is, in a great measure, a matter of chance.

TOBACCO.

The extensive use which is made of this plant in all countries of Europe, where it is not prohibited or restricted from financial motives, has caused its cultivation to be preferred to that of other marketable vegetables; the profit arising from it varies according to the influence exerted by naval warfare upon commercial transactions.

It has been found, however, that proprietors of large estates derive greater advantage from transferring the actual cultivation of the plant to small cultivators of active and industrious habits, than by having these operations executed at their own expense. Accordingly, when the soil has been completely prepared and properly manured for the growth of tobacco, it is sometimes let out to these cultivators either at a fixed price, or with an understanding that they are to have part of the produce. This last method is the one most generally approved, because it induces both planter and proprietor to take equal interest in the success of the crop. Hence, in all districts where the culture of tobacco is known, there has arisen a class of persons called planters, who, during the summer months, employ themselves solely in the cultivation of this plant. Where the soil is bad, the proprietor and the planter share the produce equally between them: but when it is very good, the proprietor gives up only two-fifths of the produce. The proprietor furnishes the soil, manure, preparatory ploughings, and drying-shed: the planter performs all the rest of the labour, and rears the plants; the proprietor supplying wood and dung for the seed-bed, and lending his teams for housing the crop. The expenses of sale and carriage to market are borne in common. But the families of planters who engage in these undertakings must be possessed of some little property, and be able to maintain themselves till the time arrives for disposing of the crop. The planter must also derive some profit from the undertaking, in addition to the remuneration for his labour.

The average produce of tobacco may be reckoned at about 8 quintals per acre; and, as a quintal sells for 5 rix-dollars, the produce of an acre may be valued at 40 rix-dollars: of these the proprietor takes 24, and the planter 16. A clever and industrious planter can, with the help of his family, cultivate 12 acres: he can, therefore, gain 192 rix-dollars during the time that he devotes to the planting, culture, and drying of the plant: he is, however, obliged at the time when there is the greatest quantity of work in hand, to employ a few assistants, whom he pays out of his own pocket.

Tobacco leaves the soil in a good state of preparation for other produce: it completely supplies the place of fallowing. According to general observation, the crop which succeeds it is in no respect inferior to that which comes after a dead fallow, provided the tobacco-soil has received four waggon-loads of dung per acre more than the fallow. This dung forms the chief item of expenditure that must be laid to the charge of the tobacco-crop; and for this reason the culture of tobacco is most practised in places where dung can be obtained at a low price.

A point of great importance for carrying on this cultivation on a large scale is the possession of spacious drying-sheds. Every barn, cart-shed, and stable is made available for this purpose. Tobacco does not even suffer in quality by being hung up in stables above the cattle.

Many operations in the culture of tobacco might, doubtless, be greatly expedited by the use of the horse-hoe; but as there are also many parts of it which must be performed by manual labour, at stated times, and with considerable accuracy, it seems best, on the whole, for the great cultivator to leave the entire course of operations in the hands of the planter.

I shall not, therefore, describe the minor operations in the cultivation of tobacco which are the business of the planter, but only those which are within the province of the great cultivator.

Various species of tobacco have been recommended for cultivation; but the ordinary Virginian tobacco (*nicotiana tabacum*) has obtained the preference before all others. That which, under the name of common green tobacco (*nicotiana rustica*), has been so much extolled by some persons, has not been found successful in the long run. Cultivation has, however, produced several varieties of the former species, particularly one which grows to a large size, and another much smaller.

Tobacco prefers a light soil; it thrives better on a sandy than on an argillaceous soil. Sandy clays agree with it best; but it is also successful on soft clays, which contain a large quantity of humus. But to produce a perfect and plentiful crop, the land must be rich in ancient humus; and must, besides, have been recently fertilized with some sort of manure. The best tobacco is that which grows on clearings, especially if the turf which covered their surface has been burned upon them; and still better if the wood which grew upon them, or wood brought for the purpose, has also been consumed on the spot and reduced to ashes. It is, certainly, to this treatment, rather than to difference of climate, that we must attribute the great superiority of the American tobacco, which is grown not on land recently dunged, but, on the contrary, after ten or twelve crops, all obtained without the use of dung, on the rich and burnt clearings of Rhode Island. Our manufacturers are also aware that the leaves of tobacco grown on land of this description are far preferable, both for sweetness and scent, to those produced from land recently dunged. In commerce, however, they will not admit this fact, from fear of having to pay a higher price for the former—a price which certainly ought to be, and will be obtained as soon as the superiority of that description of tobacco becomes generally known.

The tobacco next in value to that just mentioned, is that grown on a soil rich in humus, after manuring with lime, marl, or ashes; manures which would have but little effect on the plants if the land were poor and exhausted. The growth of tobacco is usually forced with dung, a mode of treatment which always produces that acrid taste and unpleasant odour which manufacturers have sought in vain to remove by various modes of preparation. But as this kind of tobacco is most commonly met with in commerce, it must certainly find purchasers in the market.

Land is prepared for tobacco in the same manner as for other weeded crops. The stubble is cleared off in autumn. The dung is carted and spread as much as possible before winter. In spring, this dung is buried by a superficial ploughing; and then, a little before planting, the land is ploughed deeply, in order to lighten the upper stratum of the soil.

The success of tobacco mainly depends on planting as soon as possible: in the month of May, if circumstances permit. For this purpose plants of sufficient strength must be ready at hand, and the soil must previously have been prepared in the manner required.

The remaining treatment, which is the business of the planter, does not, as already observed, come under our present observations. It may be found described at length in various manuals of agriculture.*

In countries where the practice of committing the plantation, after culture and gathering of tobacco, to the hands of planters, in consideration of their receiving a part of the produce, is generally adopted, the conditions of this compact are already defined. More detailed instructions on this matter may be seen in the work of Count Podeivil's, entitled, "Wirthschaftserfahrungen," part i. page 75. In countries where this custom is not already established, the proprietor must be content at first with making a somewhat disadvantageous agreement: but planters will soon become more moderate in their demands when they learn by experience the advantage which they may derive from such an undertaking, on a soil adapted for the growth of tobacco, and properly manured.

As the carriage of tobacco is easy, it is unwise to allow a long road to deter us from taking it to a market where a large assemblage of buyers will insure high prices. The price of tobacco usually rises in spring and summer; but as it then contains a smaller quantity of moisture, its weight is likewise diminished.

The stems of the tobacco plant have been advantageously used in the manufacture of potash; for they contain a large quantity of alkali. If the ground is to be sown in autumn, these stems must be taken up; but if the tobacco is to be followed by a spring crop, they will be sufficiently decomposed during the winter to prevent them from interfering with the spring-ploughing: and it is certain that they restore to the land a portion of the nutritive matter which the tobacco has absorbed from it.

Some cultivators have thought it advisable to leave standing a larger number of stems than they require for obtaining the necessary quantity of seed, and to employ

* Also in the following works:—"Kling; der Tabaksbau für den Pfälzischen Landsmann," 1798. "Korge; Unterricht zum Anbau des Tabaks," Breslau, 1773. "Rieben; Anleitung zum Tabaksbau," Dresden, 1789. "Christ; Anweisung zum einträgbchsten Tabaksbau," Frankfort, 1799. "Traite; complet de la culture, fabrication et vente du tabac," Paris, 1791. A.

the surplus seed for obtaining oil. The seed of tobacco yields a fair proportion of oil, of tolerably good quality.

CHICCORY.

Of all plants which have been proposed as substitutes for coffee, and which, when roasted and steeped in boiling water, yield an infusion resembling coffee, chiccory is the only one which has maintained its ground. It has been used in this manner for thirty years, even when the price of coffee has been low; and has always yielded considerable profits, both to manufacturers who prepare it in large quantities, and those who cultivate it in their neighbourhood. In countries where this plant has been cultivated, land on which it is grown has been known to give a return of 16, 20, or 24 rix-dollars, without previous manuring or preparation.

Chiccory requires an argillaceous soil mixed with sand; light, deep, and rich. The soil must also be turned up to a considerable depth; an operation which is performed with the spade in districts where there are no ploughs made to go deep into the ground. It is usual to manure for this crop with very rotten cow-dung: a small quantity only is used, as too much manure causes the roots of the chiccory to throw out a great number of filaments, and to acquire an unpleasant flavour. Chiccory is sown in the spring; generally broadcast, like carrots. Some persons, however, who raise the plant in large quantities, have obtained very good results by drilling it, and cultivating with the horse-hoe; they have thus saved a great part of the expense of weeding and thinning the plants.

The haulm may, according to some persons, be cut at the end of July or the beginning of August, without injury to the roots. A plentiful supply of fodder is thus obtained.

The roots, carefully taken up with the spade or fork, may be sold while fresh in the neighbourhood of the chiccory works; otherwise it is necessary to cut and dry them.

It is of importance that all the roots be carefully removed from the soil; as they will otherwise shoot up again like weeds, spread very rapidly, and be difficult to eradicate. It has also been remarked that chiccory exhausts the soil to a great degree; and that good lands have, by the production of repeated crops of this plant, been so much impoverished that a large expenditure of labour and manure has been required to restore them to their pristine fertility.

Chiccory has been also cultivated as a fodder-plant, first in France, and afterwards, upon Arthur Young's recommendation, in England. The principal crop is not obtained till the second year: it is said to be more abundant than that afforded by any other herbage-plant. In the trials which I have made of this plant, I have certainly obtained a very plentiful crop, which was eaten with avidity by horned cattle, and had a good effect on the quality of their milk. The chiccory afterwards put forth its flower-stalks with great vigour, without producing new radical leaves. The stalks yielded but an insignificant produce, which was rejected by the cattle: I am, therefore, of opinion that chiccory is not adapted for this purpose. The English, and particularly Arthur Young, have used it chiefly as pasturage for sheep, and found it very useful in this respect; for a small extent of chiccory ground will fatten a large number of sheep. When the plant is continually cropped by the sheep, it must necessarily shoot forth close to the ground; it will then, undoubtedly, go on for a longer time, producing radical leaves. The high stems would certainly not afford proper nourishment for these animals. Chiccory may be used in this manner for a number of successive years. I can say nothing about the manner of ridding the soil of it: I have always found it very troublesome in this respect. The preceding observations must, therefore, be regarded rather as a notice than a recommendation of chiccory.

CARRAWAY (CARUM CARUI).

This is a biennial plant; it must be sown early in spring, and does not produce seed till the following year.

It therefore occupies the ground for two years; and as it cannot be successfully cultivated excepting on the richest soils, the rent of the land for two years must be laid to its account, unless some other plant can be cultivated on the same ground during the first year, and thus made to pay part of the rent.

Where the culture of carraway is pursued according to the most approved method, as, for example, in the neighbourhood of Halle, the plants are raised in a seed-bed, which is often made and sown in autumn, but more generally at the beginning of spring. The land is prepared for this crop in the same manner as for weeded crops.

The planting takes place on St. John's day. Rows of carraway are planted alternately with rows of cabbage, turnips, or beet-root: the after-culture is performed with the hoe. The last-mentioned plants are pulled up in autumn, and the carraway left alone in the ground. In the following spring, one or two cultivations are performed with the hoe. The seed ripens about St. John's day. The plants are then either reaped or pulled up.

Some cultivators sow carraway on the ground in which it is to remain, after having prepared the soil in the proper manner: they sow the carraway either alone, or alternately with carrots, poppies, flax, or even spring-corn: they then weed and thin the plants. In autumn, or the following spring, they manure the land either with compost or poultry-dung, and gather the crop without transplanting.

I cannot pretend to decide upon the comparative merits of these two methods: this can be done only by cultivators who have tried both for a series of years, and have been at the pains of calculating the outlay and return. The method of transplanting has the advantage of allowing a longer time for cleaning the land well.

Carraway cannot be grown successfully, excepting on strong first-class wheat-land, very rich black clay, or, at all events, on land of average fertility, well-situated, and cultivated like a garden. On such lands, it rarely fails, and always stands the winter well.

In gathering carraway, the same precautions are necessary as in gathering colza, to prevent the seed from being shed. It is either reaped or pulled up, and then carefully removed: sometimes, however, it is threshed on the ground.

The price of carraway is, in almost all countries, high enough to render its cultivation profitable. But the cultivator cannot trouble himself with the minute details of sale; he must, therefore, give up the greater part of the profit to the dealer.

A large consumption in the brandy distillery might render the culture of carraway very profitable.

COMMON FENNEL (FŒNICULUM VULGARE.)

Fennel is cultivated and treated in the same manner as carraway. Its principal use is in pharmacy: but confectioners and liqueur-merchants also employ it.

ANISE (PIMPINELLE ANISUM.)

This plant is an annual: it is sown in spring, and ripens at the beginning of autumn: it is usually grown among carrots, and treated in the same manner.

I say nothing about the culture of other plants whose roots are used in pharmacy, partly because I have no actual knowledge either from my own experience, or from observation of the culture of many of them, such as *Saffron*, *Liquorice*, *Camomile*, and *Mint*, all of which are but little suited to our climate; partly because I consider that many plants of the same class, such as *Rhubarb*, the *Rose*, and *Lavender*, belong more properly to the province of the gardener. The raising of these plants as field-crops may, however, be advantageous on good soils, and under favourable circumstances. In carrying on the cultivation of such plants, the safest plan is to make bargains beforehand with wholesale druggists, and to assure ourselves, by trials on a small scale, of the success and quality of the plant, the cultivation of which we are about to undertake. We now proceed to the

CULTURE OF FODDER PLANTS.

Under this denomination we shall include vegetables which are also used as food for man, but are grown on large extents of land, chiefly to be employed in feeding cattle.

We shall first speak of those which are most advantageously cultivated with the horse-hoe, provided attention be paid to what has been previously said of this mode of cultivation.

The Potato.

It is about 265 years since this plant, now so completely a necessary of life, was first introduced into Europe. It was brought from Santa Fe, by John Hawkings, in 1565. At that time it was solely cultivated in gardens, as an object of curiosity, and eaten as a luxury.

It was not till 1623 that Sir Walter Raleigh introduced into Ireland the use which was already made of it in Virginia. It was, however, pretty well known in Italy as early as the year 1588, and was probably introduced at that time into Germany, though it did not become well known in the latter country till about the year 1710. After that time it was regarded as a common plant, and cultivated in gardens; it was, however, more frequently seen on the tables of the rich than on those of the poor. In 1760, towards the end of the seven years' war, the use of the potato became more general; but in most countries, its cultivation in the open field was still regarded as extraordinary, extravagant, and inconsistent. It was not till 1771 and 1772 that the practice of cultivating the potato as a field-crop began to acquire supporters; but at that time all the grain crops failed, and the famine which ensued led to the discovery that proper and sufficient nourishment might be derived from those very potatoes which had hitherto been regarded only as a luxury, just as well as from bread. Still the cultivation of this plant did not exceed the wants of man himself. It was not till a later period that the practice of giving the refuse and surplus to the cattle began to creep in. But it was thus gradually discovered that potatoes might be advantageously cultivated as food for live stock. Bergen, in his "Introduction to the Management of Live Stock" ("Anleitung zur Viehzuct"), was the first to recommend the practice of this cultivation on a large scale, and the use of a kind of horse-hoe to save manual labour. At the present day it appears scarcely credible that the extreme utility of this plant should have so long remained unknown, and that so much difference of opinion should have existed on the propriety of raising it on extensive tracts of land.

There is no plant to which I have paid greater attention than to the potato. Even before I entered upon the practice of agriculture, my attention was excited by the innumerable varieties which were produced by raising it from seed. I treated it in various ways at that time, merely with a view to vegetable physiology, my object being to discover whether the distinguishing characters of these varieties were due to the nature of the soil, or to the mode of fertilizing it. Since that time I have, in raising the potato, tried all the methods proposed by others, as well as those which I have myself devised. As far as the quantity of produce is concerned, the results of various modes of planting and cultivating have shown but little difference, unless, indeed, the cultivation were altogether badly arranged or neglected. The quantity of produce was found to depend on the soil when the species cultivated was the same. But the manual labour required, and, consequently, the net profit, varied considerably. I have done my utmost to reduce this manual labour to the smallest possible amount without sensibly diminishing the produce; for, in the raising of potatoes, the rent of land is much less considerable than the expenses of cultivation. I will venture to assert that I have attained this object more nearly than any one else, and that I have found myself nearer and nearer to it at the end of almost every successive year. I therefore beg those persons who have read my former works, and the observations which I have made on the culture of the potato in the first and third volumes of my "English Agriculture," in my "Anmerkurgen zu Bergen's Viechzucht," and in the "Annals," to consider such observations as the result of my apprenticeship, and those which I am now about to make, as more complete and matured.

In order to make some sort of classification of the innumerable varieties of the potato, we must confine our attention to the most useful part—the tuber. It is true that the leaves and flowers appear to bear some relation to the form of the tuber; but the particular examination of them belongs more properly to the *botanical cultivator*. We cannot expect that this examination will be undertaken either by the mere botanist or the mere cultivator.

The skin of the potato is, in some varieties, of a dark colour, approaching almost to blackness; in others, of a reddish violet, which varies to pale, brownish, or yellowish red; in others, again, of a whitish yellow.

The colour of the flesh is sometimes yellow; sometimes whitish, or perfectly white; and sometimes slightly tinged with red.

The several varieties of the potato have different times of arriving at maturity; that is to say, at the state in which the tubers are detached from the maternal plant, and the latter dies. There are some that can be cultivated more than once in the same summer, and on the same land.

But the points of difference which we have chiefly to consider relate to the consistence of the potato and the quantity of starch contained in it. Some varieties are very spongy, their interstices are filled with water, their specific gravity is small, and they contain but a small quantity of nutriment in a given bulk.

The flavour of some potatoes is very agreeable; of others, very disagreeable. Some improve by keeping; others are best when fresh-gathered.

Some cook speedily and burst; others resist the action of steam and hot water for a long time.

Some varieties require a dry soil, becoming quite watery and hollow in the middle when grown on land which contains much moisture; they also secrete water in their cavities. Others, on the contrary, remain very small, and are scarcely worth the expense of cultivation when sown on a dry soil.

Some put out long filaments into the soil; others press their tubers so closely together, that they show themselves above ground.

Some potatoes thrive particularly well on marshy land; others perish on it, and thrive on an argillaceous soil.

All these particulars must be taken into account, when a selection is to be made of varieties for cultivation. The culture of a new variety should never be undertaken on a large scale, till a proper trial has been made of it.

The amount of produce of each variety must be taken into consideration, but the value calculated according to the quantity of nutritive matter contained in it. This may be judged of approximately by the sensation which the fleshy part of the tuber produces when applied to the tongue; or more accurately, by cutting the tubers in pieces, drying them, and comparing their weight in the dried state with what it was before; but an accurate estimate is only to be obtained by chemical analysis. Great bulk is by no means desirable, if it be not attended with increase in the quantity of starch; for the potatoes then take up more room, although their intrinsic value remains the same; and they are more likely to be spoiled. In other respects, when potatoes are cultivated for sale, the choice must be directed by the taste of purchasers, and the price which they will fetch in the market.

As to the nomenclature of potatoes, the confusion which exists both in England and Germany, in the names even of the most ordinary varieties is so great, that to avoid misunderstanding I must altogether refrain from speaking of it. Under the denominations of English, Dutch, Rhenish, Holstein, and Polish potatoes, varieties totally different are indiscriminately designated in different places.

I used formerly to make frequent attempts to raise potatoes from seed. This method is interesting to an amateur gardener. He may, perchance, obtain the merit of giving rise to a new variety of good quality; but it is not economical; for, unless it be tried on hot-beds, the tubers will take too long a time to attain their full size; and, what is more, the result will almost always be a mixture of varieties difficult to distinguish; and even if it preserve its identity, presenting an inconvenient assemblage of different qualities. The different varieties may be kept separate, because they germinate and ripen at different times. These observations are not meant to apply to the cultivation of the potato in gardens.

Potatoes will grow on soils of all descriptions, and in favourable weather will yield a good crop, even on moving sand, provided that it has been well-manured. On a stony soil, well prepared, and lightened with dung, containing straw, the success of the potato is certain; though a sandy soil is best adapted to it.

On clearings and marsh-lands, provided the soil has been well drained, and especially if the turf has been burnt upon it, potatoes thrive particularly well, and sometimes yield a very large produce.

The cultivation of the potato as a field crop has hitherto taken place chiefly on the fallow-field; and it has been proved, that when properly executed, this cultivation fulfils all the advantages of fallowing. The produce of the autumn-grain which follows the potato-crop is, however, somewhat diminished; this fact has been established by conclusive experiments, and is uncontradicted, excepting by a small number of particular cases. As there is usually an objection to the sacrifice of the autumn grain which succeeds the fallow, many of the ablest followers of the three-field system have resorted to the method of setting their potatoes on the spring corn field, giving them perhaps a little dung, following a crop of peas, which doubtless thrive remarkably well in that situation: the rotation is then recommenced.

It is generally admitted that potatoes grow larger after recent manuring; they will, however, yield a good crop even when raised as a second or third crop: but the soil will then be greatly exhausted. I have never even thought of asserting that potatoes do not impoverish the soil; on the contrary, I have stated that they do so. (English Agriculture, vol. ii. page 237): they do not, however, exhaust the resources of the establishment in general, but increase those resources to a considerable extent, *if they are given as food to the cattle.*

On strong land, fresh dung mixed with straw is most beneficial to potatoes, and the more so in proportion to the closeness of its contact with them: it should, therefore, not be carted and put into the ground till just before the seed-time ploughing. But for light soils, the dung must either be in a more advanced stage of decomposition, or it must be mixed with the earth by several ploughings.

Very healthy potatoes are also produced by the use of other active manures, such as scrapings of horn spread in the furrows at the seed-time ploughing, rags of wool, and the refuse of the tan-yard. Turning sheep on to the field after the potatoes have been set, is likewise very efficacious in promoting their growth, but it gives the tubers a bad flavour. There is also a limit to the degree of cultivation proper for potatoes: if it be surpassed, the haulm becomes excessively large, and falls upon the ground; the number of tubers in then much diminished.

In setting potatoes, it is necessary to select the most healthy and vigorous tubers; not such as have already been deprived of two or three of their buds, because the most vigorous buds are always the first chosen. Especially must those be rejected which have been much exposed to cold, even though they should not have been injured by frost. Potatoes grown in pits, mounds, or hollows, where frost has penetrated and destroyed a portion of the tubers, are very uncertain in plantations: I am sure of this from my own experience. They either do not shoot up at all, or produce but feeble plants; great care should, therefore, be taken to preserve those which are intended for setting.

I am aware that many cultivators have obtained abundant crops of large potatoes by planting none but small tubers: nevertheless, I prefer setting those of large and average size, especially for certain varieties. Small tubers have not the same power of germination as large ones, and often do not germinate at all; whereas, those of large size may without injury be cut in halves. When circumstances are otherwise favourable, very strong plants are often obtained by setting mere cuttings of potato containing a single eye; or even the eye by itself; or, lastly, the mere skin. But on heavy land which has not been well pulverized, as well as on a sandy soil, there is great danger of failure, if, after setting or during germination, the weather should be unfavourable to the formation of the plant. To ensure success, this plant must by means of its feeble roots immediately seek for nourishment in the soil. It must not encounter a hard piece of ground; for, as it derives no nourishment from the maternal plant, it would then dry up and perish. I therefore abandon this method altogether, although I formerly recommended it: it succeeds very well in gardens, but is very uncertain for potato-crops grown in the open field. The same may be said of shoots planted after having been cut from growing plants.

There will always be a difference of opinion touching the expediency of setting potatoes close together, or far apart; for the decision of this matter depends upon adventitious circumstances: but repeated trials accurately described by the estimable J. N. Schwertz, in the "*German Agricultural Gazette*," seem to show that the quantity of produce is, to a considerable extent, in proportion to that of the sets. The practical results of these trials are as follows:—

1. The amount of *net* produce, deduction being made for the quantity of potatoes used for setting, bears a tolerably exact proportion to the latter quantity—that is to say, that one who sets a larger quantity of tubers, will usually obtain a more abundant crop, than one who sets a smaller quantity.

2. Fine large tubers produce not only larger potatoes, but also a greater number of them.

3. The degeneracy often observed in potatoes appa-

rently results from the use of unhealthy plants for setting.

4. Small tubers, and those which are destitute of buds, cannot by any means be recommended for setting.

5. When potatoes of medium quality are planted, it is better to set them whole: but when the tubers are very large, the halves will be found sufficient, provided, however, that they are set rather closely in the rows.

6. It is not advisable to cut a potato into more than two pieces.

7. It is better to set the tubers one by one and close together, than to put a number of them into the ground together, particularly when all the labour is performed with the plough, and no cultivation is given with the hand-hoe.

8. It is not advisable to plant mere buds; they often fail.*

I give these principles as being in accordance with my own experiments made on the large scale, with the exception, however, of the first. It does appear, from actual experiment, that the quantity of produce is in proportion to that of the potatoes put into the ground. The author deduces a result by dividing his plantation into two parts. In one of these he places the trials in which the quantity set amounted to more than 1·254; and in the other, those in which this quantity was less. In the former, the net produce of each row was 16·81; in the latter, only 15·41. These two results are in the proportion of 1000 to 917. The loss in the latter is, therefore, 8 $\frac{1}{3}$ per cent: but the difference in the relative quantity of the sets is much greater. Then again, among the trials included in the latter division, there are several which ought not to be included in the comparison: where, for example, the sets consisted of buds, or mere eyes, or handfulls of very small scattered shoots, all of which gave but a very insignificant produce. If we take into account those trials only in which good potatoes, or cuttings of them, were set at intervals of 1, 2, 3, or 4 decimetres, it will be

* "Landwirthschaftliche Zeitung." 1809. Seite, 568.

found that the difference is very small, not exceeding $2\frac{1}{2}$ per cent.

I am willing to admit the existence of this difference, and even of one of five per cent., if the potatoes are set in one part of the rows at eight inches and in another at twenty-four inches distance; so that the quantity of sets used for the former shall be three times as great as that used for the latter. The quantity obtained from the half in which the potatoes are at the greatest distance apart will not amount to more than ninety-five bushels beyond that of the sets, while the produce of the other half will amount to one hundred bushels.

On the other hand, the practice of setting at greater distances is attended with the following advantages, in field-cultivation.

1. Potatoes, especially those fit for setting, fetch a much higher price in spring than in autumn, which is the time for gathering; the keeping of them occasions both trouble and risk, and there is always a portion spoiled. Suppose that the difference in the two prices amounts to one-third only of the greater, or that a scheffel which in autumn is worth eight groschen costs only twelve in spring. The increase in price of these eight scheffels amounts to thirty-two groschen. The five scheffels obtained from the crop amount to forty groschen, so that the profit is reduced to eight groschen.

2. Setting at greater distances occasions saving of manual labour.

3. When the plantations are laid out in rows in all directions, and the distances between the rows wide enough to allow the plough to pass crosswise, almost all the manual labour which would otherwise be required to weed the interspaces is saved.

4. These ploughings are much more efficacious in cleansing, pulverising, and aerating the land, than they would be if performed in one direction only. Dog's-grass in particular, which multiplies so rapidly between continued lines, is entirely destroyed by this treatment; so that the object of fallowing, one of the principal ends

of the culture of weeded crops, is completely attained. I say nothing about the effect produced on the potatoes themselves by cultivation on all sides, since we have admitted, for argument's sake, that those which are cultivated on one side only yield the greatest increase.

5. The gathering of potatoes is performed with far greater ease and despatch when they grow on separate hillocks, than when they are arranged in continuous lines. My labourers are more willing to raise potatoes planted singly, for the fourteenth part of the produce, than for the tenth, when they are planted in rows; for a man can raise eighteen scheffels of the former in a day, whereas he will not be able to raise more than ten of the latter, even though they may have been cultivated with the same care. This saving of time in taking the crop is of great importance.

Such are the reasons which induce me to prefer the method of setting potatoes at moderate distances, and arranging them in lines in all directions. I admit that when this method is adopted, a somewhat larger extent of surface is required for the production of a given quantity; but the great saving of labour, and the excellent preparation of the land which it affords, are of much greater importance. Nevertheless, the case may be different with regard to those who have but a small quantity of land to devote to this description of produce.

In adopting this method, it is also necessary—

1. To employ in setting the potatoes none but steady and intelligent labourers, who will not omit to set them in any place where they ought to grow.

2. To set none but very healthy potatoes.

3. To prepare the soil in such a manner that the germination of the plants shall not be hindered.

Any one who is either unwilling or unable to get these conditions fulfilled, will do better to set his potatoes more thickly, or in pairs; otherwise, a plantation thus formed will be likely to contain a great many vacant spaces, and considerable loss will be the result.

In setting potatoes regard must be had to the state of the weather. In this country I never plant them till the soil has become heated; and I have always observed that the potatoes set last were the first to come up. I have planted them with success till the beginning of June; but I endeavour to get the setting finished towards the middle of May. If it be desired to plant them later, they may be previously made to germinate in a warm place. If the soil contain ever so small a quantity of clay, it is absolutely necessary to defer the planting till it is perfectly dry, and no longer adheres to the implements.

As early as possible in autumn I break up the soil to the depth of two inches lower than before, and then pass the harrow over it. In winter the dung is carted and uniformly spread. At the beginning of spring, this dung is buried by a light ploughing; and the harrow passed over before the seed-time ploughing. I like to have a portion of the manure brought up to the surface by this operation, because a greater quantity is then collected around the roots of the potatoes.

I have only once tried planting with the spade, along a cord on which the distances were marked by knots; this was my first essay of the mode of planting in squares. If I had not found out another method, the tediousness of this one would have wearied me.

The potatoes are set in furrows traced with the plough, and the mode of proceeding is as follows:—

By means of the *marking-plough* or furrower, already noticed, lines or small furrows are traced at right angles or obliquely, to the direction which the plough is to take. Five persons are then stationed at equal distances on the line of the plough, each having assigned to him the space which he is to plant. One plough traces the first furrow, which is immediately set with potatoes. Two other ploughs then follow, and the potatoes are set in the furrow traced by the third. It will be understood that the persons who set them have to go from one side to the other, each one keeping within his allotted space. Each potato is set at the point of intersection of the line traced by the marker, with the furrow formed by the plough. It is of importance that the potatoes be set as close as possible to the perpendicular side of the furrow, and not on that where the slice has been turned over; for, in the former position, the potato is more likely to remain in its place, and not to be disturbed by the horse's foot.

The best ploughman must be employed to trace the furrow in which the potatoes are set; first, to ensure that the furrow may be of a proper and uniform depth, three inches on a heavy, and four or five on a sandy soil; secondly, to enable him to correct any errors which the others may have made in the width of their furrows. This first ploughman always traces the first furrow in commencing a new bed. The width of the beds must be measured at the two extremities, and poles set up there, in order to preserve as much as possible the parallelism of the beds.

If the labourers are well practised, three ploughs and five planters will finish eight acres per day, or six at the least. Each planter must have his sack of potatoes within his reach.

A week after the setting, the ground is harrowed, an operation by which a few weeds are destroyed. Great numbers of them afterwards spring up. Nothing more is, however, done to get rid of them till the potatoes are about to spring up, and some of them just beginning to show their leaves above ground. The extirpator is then passed lightly over the whole surface of the field. This may be done without fear of hurting the potatoes. The whole of the weeds are thus destroyed. The soil is left in this state till all the potatoes have come up, and is then harrowed to level it. After this harrowing the potatoes are as clean as if they had been carefully weeded, so that it only remains to pass the scarifier or horse-rake over them.

No injury will result from the plants not having been originally set in rows in all directions, for the first cultivation with the horse-hoe will place them so. It seems, indeed, as if they were benefited by a little compression on one side.

The first cultivation is performed with the small hoe, and should be given in the direction followed by the marking plough or furrower; the second must be performed with the horse-hoe, and in the direction of the plough. This will be sufficient in the greater number of cases. The haulm will then recover itself, and shade the whole field. If a few weeds should have escaped here and there by growing close to the potatoes, it will cost but little labour to pull them up while yet in flower.

If a third cultivation be thought necessary, it is performed in the same direction as the last. It would be difficult to recut the sides and edges formed by this last cultivation, especially, if the potatoes be somewhat advanced in their growth.

By these operations, the cultivation of the potatoes is completely finished before harvest-time; and nothing remains to be done to them till they are ready for taking up.

When the soil is tenacious and exposed to humidity, I prefer the following method of cultivation:—

The soil having been well prepared, lines crossing transversely are traced with the marking-plough, and a potato set at each intersection. The planting goes on much more quickly in this way: one man can easily plant three acres per day. The small horse-hoe is then passed close to each row, and covers it completely with earth. When weeds spring up, they are destroyed by passing the large horse-hoe in the same direction, an operation which is performed whether the potatoes have come up or not. When the potatoes have grown up to a certain height, the banks or edges formed by the hoe in the last cultivation are cut transversely with the large hoe. Another and final cultivation is perhaps given in the direction of the first.

The advantages presented by this method when applied to an argillaceous soil, are very striking. The potato is surrounded on all sides by light earth, and dung heaped round it. It is completely preserved from any excess of moisture that might injure the crop, because it is placed above the bottom of the furrow, by which the water drains off. The soil in which it rests is also thoroughly warmed by the sun.

But the use of the extirpator, by which so much good is effected, is entirely precluded by this method; neither can the paring plough be used. The difficulty of keeping weeds under is thereby increased; and it therefore becomes of great importance to perform the cultivation at the exact time when the soil is in the proper condition: otherwise we shall be reduced to the necessity of weeding and cultivating with the hand-hoe. This method is, however, by no means proper for dry and sandy soils; for it would cause the plants to suffer in dry weather. And lastly, a sharpish frost attacking the potatoes before they were gathered, might penetrate too deeply into the ridges. I therefore recommend this method for those soils only in which potatoes might suffer from excess of moisture.

As to the other methods in use, I refer to my observations on them in the first and third volumes of my "English Agriculture." For my own part, I confine myself to the two methods just described.

When the earth has been laid up for the last time, and the potatoes begin to blossom, they must be left quiet; for it is then that the young tubers are formed. Some persons have recommended that the flowers be cut off, in order to increase the growth of the tubers; but the recommendation is absurd. Cullen, of Edinburgh, observed some time ago that the development of the tubers keeps pace with that of the flowers; and experiments specially directed to this point have uniformly shown that the crop is much injured by the removal of the flowers.

Cullen also tried the effect of cutting off the leaves as fast as they grew; the consequence was, that the potatoes produced no tubers, but merely filamentous roots. The experiments of Anderson, showing the injury occasioned to potatoes by the hasty removal of their leaves, are recorded in the first volume of my "English Agriculture," p. 403.

The digging the crop has always been looked upon by great cultivators as the most difficult part of this branch of husbandry, and has been the main cause of their unwillingness to undertake it on the large scale. Since the year 1798, however, when I first took upon myself to recommend the cultivation of potatoes, this fear has greatly diminished; it has, indeed, been found that the getting in may be performed with greater facility and expedition than was formerly thought possible. It takes place at a favourable time, when the women and children have nothing else to do, and the weather is commonly fine. It is a labour which they willingly undertake, being encouraged in it by the idea that they are earning their subsistence for the winter. For my part, I know no method more appropriate than that of paying them with part of the produce: if the potatoes are planted according to my method, they do it cheerfully for a twelfth of the produce; sometimes, when my potatoes have been very successful and those of other persons are not particularly fine, even for the fifteenth. If they get more than they can either consume or preserve, the surplus is purchased of them at a fixed price. The work goes on very quickly: those who perform it employ their children to help them; whereas, if executed by day-labour it would be very tedious.

Potatoes are taken up by means of a vine-dresser's mattock, which has two points, after they have been cut and stripped of their haulm. When they are planted according to my method, one man can with such an instrument easily prepare work for twelve pickers. In this manner potatoes may be taken up at less cost than with the plough. The latter method is, moreover, attended with various inconveniences, especially that of not enabling us to determine beforehand the quantity that will be raised in a day; in consequence of which a portion may be left unhoused at night, and injured by frost. The mattock just spoken of takes up all the tubers so completely, that I have never thought it worth while to go over the field a second time for the purpose of collecting any which might have been left behind.

It is very extravagant to use sacks in gathering potatoes; they never last more than a year. I make use of boxes, which hold about thirty bushels, and are placed on waggons. In one side of these boxes is an opening, which shuts by means of a sliding door. When the boxes arrive at the barn, the door is opened, and a kind of gutter adapted to the opening, and along this gutter the potatoes descend to the place intended for them. These boxes are likewise useful for other purposes.

Potatoes dug in dry weather may with safety be placed immediately in a cellar, or store-house protected from frost; but the place in which they are kept must be left open, to afford a free circulation of air, till cold weather comes on. But if the potatoes are raised in damp weather, it is better to spread them out on a floor, and let them dry there.

Cellars or houses protected from frost by double walls, are certainly the best places in which potatoes can be kept. These vegetables may, however, be perfectly well preserved in heaps, covered with straw: when packed in this way they are quite out of the reach of danger from frost, and keep better than in pits. Heaps of potatoes may be formed containing 20 winspels (480 scheffels) and more; but it is better to proportion their size to the room which can be given to them in the buildings, so that an entire heap may, when wanted, be carried thither at once; a day on which there is no frost being chosen for the purpose.

It is best to give these heaps an elongated form, like a roof, especially when they are large; but a point of greater importance is to cover them all over with a layer of straw, at least six inches thick. This layer of straw should be thickest near the ground: it should there extend beyond the heap of potatoes, so as completely to prevent the access of frost. The straw should be well trimmed at the summit and angles, and the whole covered up with earth. It is not, indeed, the earth which protects the potatoes from frost: this effect is produced by the straw, which prevents the radiation of heat from them; but the earth should be closely pressed to prevent the air from getting through the straw. Earth which has no consistence and easily crumbles is, therefore, unfit for the purpose; if no other can be obtained, some kind of covering must be placed over it. For this purpose we may use the haulm of the potatoes, taking care to protect it from wind by means of the hurdles used for penning sheep, or in any other convenient way. If plastic earth can be obtained, these precautions will not be required: it will then be sufficient to spread the earth equally over the whole surface; beat it carefully, in order to make it even and solid; and examine it now and then to see whether any holes have been made by the mice, by which frost may gain access to the heap.

A precaution very necessary to be observed, is not to close the heaps completely in autumn so long as the weather continues warm. A small quantity of air must be allowed access through the top till frost comes on; a vent will thus be afforded for vapours which rise from the heap. An aperture is then left in the straw at the top of the heap, and frequently examined in order to discover whether any odour, indicative of fermentation, is given off: should such be the case, a greater quantity of air must be immediately admitted. It is only when continued frosts come on that the covering must be completely closed.

Potatoes remained uninjured in heaps of this description during the winter of 1802-3, when the frost penetrated the soil to the depth of three feet, and injured all potatoes kept in pits which were not well protected on all sides with straw, and many that were kept in cellars. Covering the heaps with dung is always useless, and often mischievous.

When a thaw comes on, it is prudent to open the heaps a little at the top, to permit the escape of vapour.

It would be superfluous to add any observations on the use of the potato. Let us merely pause for a moment on the value which it bears in proportion to that of other plants, according to its nature and the quantity of nutritive matter contained in it.

To compare potatoes with rye. Good potatoes contain by weight 24 per cent. of nutritive matter, and rye 70. If a scheffel of rye weighs 82 lbs., and a scheffel of potatoes 100 lbs., 64 ½ scheffels of potatoes will be equivalent to 24 of rye.* Consequently, 2 scheffels 12 metzen of potatoes will be nearly equivalent to 1 scheffel of rye. But this estimate supposes that the tubers are good, solid, full of starch, and grown upon dry land, as was the case with those which Einhof selected for analysis. For, as later analyses have shown, the difference between the several varieties of the potato is much greater than Einhof then admitted, since the inferior varieties cannot be admitted to contain more than 20 per cent. of nutritive matter; and, consequently, 3 scheffels of them will be required to give the same result as 1 scheffel of rye.

The results obtained in brandy distilleries where the potatoes used are not of the best quality, corroborate the assertions just made. According to the most skilful practical distillers, 3 ½ scheffels of potatoes do not yield more brandy than 1 scheffel of rye: but that obtained from potatoes is the stronger of the two.

It is universally admitted, that for feeding cattle 2 scheffels of potatoes are equivalent to more than a quintal of hay, and that 1 scheffel of these tubers is worth at least half a quintal of hay; it must be understood, however, that part of the food given to the cattle must consist of hay or straw, in order to facilitate digestion.

In establishments in my neighbourhood in which cattle are fattened in large numbers, it is perfectly agreed that an ox fed with half a scheffel, or 50 lbs. of potatoes, and 5 lbs. of hay per day, fattens as quickly as if he consumed 35 lbs. of hay; and cattle-dealers prefer putting oxen on this potato-food, to giving them hay alone. Theoretically, we are unable to decide on the value of potatoes in com-

* Vide "Einhof on den Annalen des Ackerbaues." Bd. iii. S. 356, and Bd. iv. S. 627. A.

parison with hay, as positively as we can on their value relatively to grain, because their constitution is very similar to that of grain, and very different from that of hay. We must, therefore, appeal to experience for information on this matter.

In England, endless disputes have been raised about the utility of potatoes in comparison with turnips, for feeding cattle. As a result of this controversy, the great cattle feeder, Campbell, declares most positively that he cannot get, out of his own estate, 1 bushel of potatoes for 2 lbs. of beef, independently even of the dung which they would afford. Now, a bushel is equal to 0·645, or nearly $\frac{2}{3}$ scheffel. Consequently, for the nourishment of cattle, a scheffel of potatoes is equivalent to 3 lbs. of beef (free of expense).

We shall, hereafter, speak of the use of potatoes for feeding milch-cows, a mode of application on which the results of different trials are very discordant: and also of their use for feeding sheep.

As potatoes rarely constitute an object of wholesale trade, it is important to form an exact estimate of relative value for consumption, and of the price which they return to the cultivator who raises them for his own use—a price which must not be confounded with that of the markets.

According to the produce which I formerly obtained from land of average quality, well and deeply cultivated, and strongly manured, I was in the habit of considering 140 scheffels per acre of Calenberg (which exceeds that of Magdeburgh by about 4 perches) as an average produce: but in this part of the country I have not yet obtained the same amount. The largest produce that I have here obtained is 120 scheffels per Magdeburgh acre: this was in 1809. In 1810, which was a year of scarcity, I obtained but 78 scheffels: the usual amount has been between 80 and 90 scheffels. I therefore take 80 scheffels per acre above the sets, as the basis of my calculations; the quantity which I usually employ for sets amounts to 5 or 6 scheffels per acre.

Taking very moderate data, such as may always be realized, for basis of the calculation, the labour of cultivating potatoes may be estimated as follows, for 50 acres:—

	DAYS' LABOUR.			
	Of a Horse.	Of an Ox, for relay.	Of a Man.	Of a Woman.
Deep ploughing in autumn, at the rate of ⅓ acre per day's work of the plough	..	66⅔	33⅓	
Light harrowing, a team, 16 acres.....	12½	..	3⅛	
Carrying 400 waggon loads of dung; 10 loads per day by team, requiring 160 horses and 40 men, of which one-third is to be charged to the potatoes	53⅓	..	13⅓	
Loading and spreading by team, one man and one woman; one-third charged to the potatoes	..	..	13⅓	13⅓
Burying dung, 2½ acres per day	..	40	20	
Harrowing 10 acres by team	20	..	5	
This preparatory labour amounts, according to the valuations subsequently given, to the sum of 47 rix-d. 37 gros. 2 den.; or 23 gros. per acre.				
Passing the marking-plough twice crosswise, 10 acres per day	5	..	10	
Putting tubers in the ground, with 3 ploughs and 5 women, 6 acres per day	..	50	25	41⅔
One porter and superintendent.........	..	..	8⅓	
Light harrowing, 16 acres per day by team	12½	..	3⅛	
Passing the extirpator, by team, 12 acres per day.........................	16⅔	..	8⅓	
Giving first cultivation with the horse-hoe, and one horse, five acres per day	10	..	20	
Giving second cultivation with the large hoe and two horses................	20	..	20	
Pulling up weeds which may have escaped the cultivations............	..	..	..	25
Taking the crop, if performed by day-labour, 1 man and 8 women per acre.	..	..	50	400
Carting by team, 3 acres, or 12 winspels	66⅔	..	16⅔	
One labourer, to aid in housing........	..	..	16⅔	
	216⅔	156⅔	266¼	480

According to our average proportions, if a scheffel of rye be worth one rix-dollar, we must reckon—

A day's labour of a horse at............	5	groschen.
"	an ox for relay	3	"
"	a man.................	4	"
"	a woman	3	"

Hence 216¾ days' labour of a horse		1083¾	groschen.
156¾	„ an ox	470	„
266¼	„ a man	1065	„
480	„ a woman	1440	„
50 acres cost therefore		4058¾	groschen.

consequently one acre costs three rix-dollars nine groshen and two deniers.

If the crop amount to eighty-one scheffels over and above the sets per acre, each scheffel will cost one groschen.

Every one must, however, make his own calculation according to the particular circumstances of his locality.*

Let us now inquire at what amount the ground-rent and price of manure must be estimated.

If the land require from time to time a complete summer fallow, and if it be also necessary in the course of cultivation of potatoes, or any other weeded crop, to give a dead fallow, the potatoes must certainly not be charged with rent; they ought rather to claim a bonus, inasmuch as they save or rather effect the costly operation of this fallowing.

The dung and nutritive matters absorbed by potatoes must undoubtedly be laid to their account, if they are to be sold off the establishment; but if they are intended for home consumption, they scarcely absorb as much as they afterwards afford in the shape of manure. The least result given by experiments on the quantity of manure produced by potatoes shows that 100 lbs. of these vegetables given as food to the cattle yield 66 lbs. of dung; consequently, 80 scheffels of potatoes will yield 5,280 lbs. of dung; but 800 lbs. of the straw of these plants will also produce 1,840 lbs. of dung; therefore, the quantity of potatoes grown on an acre of ground will

* This is so far true, that on my property at Genthod, on the borders of the Lake of Geneva, the average cost of a horse's day's labour in the interval between the 1st of March and the 1st of November amounts to 3 francs, independently of the driver. In my Italian estates it is the same. During winter, I reckon these days' labour at one-fourth less, because they are then less useful. The average price of a man's day's labour in summer is, at Genthod, 2 francs; and on my Italian estates, 1 franc 50 cents: that of a woman, about half.—1815. French Trans. These averages have, since that time, considerably diminished, at least on my Italian estates.—1829. French Trans

yield three good waggon loads of dung, that is to say, at least as much as they consume. But how far superior is this dung to that produced by the ordinary nourishment on dry fodder! This fact is well known to every one, and has been very judiciously noted by Kähler. (Vide *Annalen des Ackerbaues*, bd. xii. s. 228.) We cannot, then, charge potatoes with the consumption of any quantity of manure, for they really furnish a large additional supply of that material, inasmuch as the animal life which they support constitutes a new and active element for its formation.

But land is often let to poor people for growing potatoes. If the land thus disposed of has been properly prepared and dunged, the produce of each perch of 12 feet square (or 144 square feet of surface) will be worth 1 groschen, making that of an acre worth 11 rix-dollars 6 groschen. From this we must deduct the cost of preparatory labours, which has been already estimated at 23 groschen; the remainder is therefore 10 rix-dollars 7 groschen.

If now we add this net profit in money to the cost of the potatoes cultivated for our own use, as a balance for rent and price of dung, the total cost will amount to 10 r.-d. 7 gr. + 3 r.-d. 9 gr. 2 den. = 13 r.-d. 16 gr. 2 den.; consequently, 1 scheffel of potatoes costs $4\frac{1}{10}$ groschen. Such, then, would be the price of the potatoes; it might be increased to 5 gr. to ensure a fair profit; potatoes have never been sold at a price lower than this. But the nutriment consumed by the potatoes is lost by this system, and if 80 scheffels grown on an acre yield 16 r.-d. 16 gr., which, after deducting 3 r.-d. 9 gr. for expenses of cultivation, leave 10 r.-d. 7 gr. net profit, it remains to be seen whether, according to the circumstances of the rural establishment, this profit is a sufficient indemnity for the quantity of manure consumed.

But if the potatoes be consumed at home, the cost of their production cannot exceed 1 gr. per scheffel, or making the fullest allowance for casualities, 1 gr. 4 den.

But potatoes used for feeding cattle fetch 6 gr., when a pound of meat is sold for 2 gr.

For information respecting the remarkable separation of the fecula of the potato by the action of frost, by means of which the essential part of these vegetables may be preserved for a long time, and exported more easily than the seed, I refer to the *Annalen des Ackerbaues*, bd. iii. s. 389, and bd. xi. s. 1. This property of the potato has not hitherto been turned to much account.

The Field-Beet.

This plant also called *mangold wurzel*, and sometimes *root of scarcity*, (*mangel wurzel*) is, with all its varieties, either a descendant of the *beta vulgaris* alone, or the result of the mixture of this plant with the *beta cacla*. I regard the difference pointed out by botanists between these two plants as too insignificant, and, as far as my observations go, too vague to serve as the foundation of an absolute distinction. It appears to me that the crossing of the deep red-coloured garden beet and the white beet has given rise to all the existing varieties of this plant, some approaching to the former, and others to the latter species; and that from these again new varieties are continually produced, among which we now and then meet with individuals belonging to one or other of the original species. It is, therefore, impossible to distinguish precisely between the various kinds of beet any more than between the several kinds of other cultivated plants, the varieties of which pass one into the other by insensible gradations.

The two kinds of beet which occupy the extremities of the series are the deep-red beet which has long been cultivated in our kitchen gardens, and that which is perfectly white. Between these there are the large scarlet beet; the flesh-coloured beet, which is sometimes marked with rings of that colour; the variety which is red without and perfectly white within; the yellow beet; and that whose colour is a mixture of yellow and white. The colour of the root commonly resembles that of the leaves or rather of their edges, which are either quite green* or tinged with red. Even seed taken exclusively from one plant always produces several different varieties. The unmixed red and white are, however, the most constant.

The pale red beet is the largest and most productive of all, and is, therefore, usually cultivated as food for cattle. There are two varieties of this; one whose root buries itself under ground, and another which shows a disposition to rise above the surface. My own observations lead me to consider these dispositions as essentially belonging to the varieties in question; but the nature of the soil has also considerable influence upon them. I once divided with a friend a quantity of seed which had been given to me as belonging to the variety which rises above ground; my plants plunged deeply into the soil, whilst those of my friend grew chiefly above the surface. My land was ploughed to the depth of ten inches, and his to a small depth only.

On a soil of small depth, the variety which grows above ground is certainly to be preferred, as on such a soil it produces a heavier crop than the other; but on a deep soil the underground variety is preferable, if only from being less exposed to injury from frost in autumn.

The yellow and white beets, on the other hand, have the advantage of possessing greater consistence, and resisting cold rather better; but chiefly because they contain a larger quantity of sugar—a fact which is asserted by all those who have made experiments on the manufacture of sugar from beet-root; they are, therefore, commonly preferred for the manufacture of sugar and syrup, perhaps also for the distillation of brandy. But for agricultural purposes, these qualities do not compensate the greater volume obtained from the reddish varieties.

Beet grows on all soils which contain a moderate quantity of moisture, and a large proportion of nutritive matter; but on sandy soils its size is small, unless,

* Rather whitish.—French Trans.

indeed, a large quantity of rain fall during the period of its growth. On a light soil, rich in humus and moist by situation, it becomes watery and very thick, but hollow in the middle, and difficult to preserve from rafting quickly. The soil best adapted for beet is an argillaceous soil possessing moderate tenacity; on land of this description it always succeeds, and acquires more consistence than on any other kind of soil. I therefore make it a rule, in the cultivation of weeded crops, to sow the greatest quantity of beet on tenacious soils, and of Swedish turnips on those which are sandy.

To produce beet of large size, the soil must be well manured; but it matters not whether the manuring has been performed expressly for the beet or for a preceding crop, provided that, in the latter case, the soil still remain in good condition. Fresh manure should be mixed with the vegetable soil by two ploughings at the least.

The deeper the soil the better is it adapted for the growth of beet; to obtain a good crop of this vegetable on a soil of small depth, it is better to sow or plant it on beds or ridges.

The seed may be then sown on the spot where the plant is to grow. The individual grains may be placed in separate holes, or the seed may be drilled at least twice as thickly as the plants are to remain: but this latter method is practicable only on a warm light soil, which is tolerably free from weeds; for the germ has some difficulty in opening the hard skin in which it is enclosed. It is a considerable time before the young plants display their seminal roots, and by that time the field is covered with weeds of considerable height. The germination is often interrupted, either because the seed is too near to the surface, and cannot find a proper supply of moisture, or because it is too deep in the ground, and development becomes impossible. The only way of getting rid of weeds is to mark the lines on which the seed has been sown, in order to destroy them with the horse-rake before the beet-plants come up: this, however, requires extraordinary attention. Beet has also been sown broadcast, and, subsequently, thinned by weeding and hoe cultivation; so that the plants are ultimately isolated: but this method is the most troublesome and expensive of all.

On ordinary soils, transplantation is usually the preferable plan, as it leaves time for giving the requisite preparation to the soil. But as the vegetation of the plant is disturbed by transplantation, it is important to procure the seedlings in good time, and, therefore, to sow as early as possible, in a very warm situation, and on a light garden soil. The seed may also be committed to the ground at the end of autumn; it will then remain dormant during the cold season, but the husk will become somewhat softened. But the trifling advance in point of time which this method affords, does not compensate for the danger to which the seed is exposed while in the ground, from the attacks of mice and insects: this circumstance has caused the plan to be almost universally abandoned.*

The plants require careful cultivation during their growth; it is upon this indeed that their success mainly depends. The cultivation is performed with the horse-hoe; but, in spite of the opinion of some agriculturists, a slight earthing up is very useful, even to the variety which grows chiefly above ground. The large fleshy leaves of the plant attain their greatest size in August; many cultivators set great value on the green-fodder furnished by these leaves. According to approximate calculations, if the leaves be stripped early and frequently, the produce which they afford is greater than that of the roots; but it is obtained at the expense of the latter:

* The method which is found to be most advantageous on my estates, consists in advancing the germination a few days before sowing, by moistening the seed with water from the dunghill, and then setting it in rows, two or three grains at a time, along a cord on which equal distances are marked. The seed is placed in little holes, about an inch or an inch and a half in depth, and formed with a dibbler: it is covered with mould taken from the preceding hollow; or, if the soil be very light, the earth is pushed over the seed by the foot of the sower as he advances. When this plan is pursued, germination takes place quickly, and the weeds do not get the start of the beet-plants. Care must be taken to uproot the superfluous plants as soon as those which are to remain have put forth three or four leaves.—FRENCH TRANS.

for, if the leaves be stripped early and to excess, the roots remain very poor. Cattle eat these leaves, but are not very fond of them; and, though large, they appear to contain but a small quantity of nutriment. Whatever is gained in real value on the leaves, is lost upon the roots: moreover, the gathering of the leaves is troublesome; and, on the whole, I think that nothing but a scarcity of other kinds of fodder can justify this operation in an economical point of view. It is only in autumn when the plants have attained their full growth, and the crop is soon to be taken off, that the leaves can be properly cut close to the root, and given to the cattle.

The roots are easily pulled up; but the removal of the filaments which is necessary to the preservation of the roots, is not so easy. Beet-roots grown in an argillaceous soil have not so many of these filaments.

It is difficult to preserve the roots to an advanced period of the winter, for they are very sensible of cold, and soon destroyed by it. In warm cellars they are very liable to rot, so that they require to be placed in beds, and separated by straw or sand. The best mode of keeping them is to place them in heaps of moderate size, and cover them with straw, in the same manner as potatoes are kept.

My own experience has shown me that the produce of beet may amount to 300 quintals per acre; this, however, is an extraordinary quantity: even on a soil especially adapted to the plant, we cannot reckon on an average crop of more than 180 quintals per acre. In the duchy of Magdeburgh, it is calculated that a square foot of land will produce a pound of beet-root: this would make 235 quintals per acre. But from this we must deduct one-fourth for accidents which may injure the crop. The quantity of nutriment contained in beet cannot be estimated at more than 10 per cent.; compared with that contained in hay, it is as 10 to 46; with that of potatoes, as 28 to 46.*

* I am inclined to think that either the northern climate, or the soil of our learned author's estates, imparts to the beet-root properties different from those which distinguish ours. With regard to the leaves, our opinions are in accord-

The large proportion of sugar which beet-root contains renders it particularly agreeable and beneficial to cattle. When given to cows it contributes greatly to the formation of milk, to which it imparts an agreeable flavour; and, when mixed with potatoes, it appears to improve the milk in an extraordinary degree.

Beet possesses the advantage of being almost exempt from the attacks of insects.

As the culture of beet for the manufacture of sugar has lately excited particular attention, I shall here add a few observations on that subject.

The best variety of beet for this purpose is the perfectly white; next to that, the yellow: the reddish variety is inferior to all others. The former have been found to be richer in saccharine matter, but their produce is much less than that of the latter. Although, therefore, in the former the separation of the sugar is easier, the rough produce which they yield is less in quantity, so that the cultivator cannot obtain them at the same price. Moreover, beet-root raised for the extraction of sugar should not be grown on a very rich and strongly manured soil, for it will then contain a great deal of saltpetre, and but little sugar. Finally, it is said that the roots must be preserved from the influence of light; they must, therefore, be covered up with earth. The variety least adapted for this purpose is that which grows chiefly above ground. The beet-plants must be placed as close together as possible, which greatly increases the expense of cultivation, and diminishes the produce. Lastly, they must not be stripped of their leaves before gathering, but allowed to

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ance; but as to the root, I am disposed, from the result of various experiments, to believe that it contributes as much, and even more, to fatten animals, than to increase their milk: it is true, however, that the roots impart an agreeable flavour to the milk, according to an experiment made upon sheep during the winter of 1809-10, to which I paid close attention for more than a month. I believe 252 lbs. of beet-root to be equivalent to 100 lbs. of natural hay.—1815. FRENCH TRANS. This proportion has been confirmed in my establishment, not only by a second direct experiment very carefully conducted, but likewise by all the results of my rural economy, in which, as is well-known, everything is submitted to the most rigorous computation; and to that which is the basis of all computation, viz., weight and measure.—1829. FRENCH TRANS.

grow covered with their leaves, which appears a great sacrifice to some cultivators.

According to calculations made upon large quantities of these roots, it appears that to render the manufacture of sugar profitable, the quintal must not cost more than 6 groschen. The cultivation of beet may be advantageous even at this price in localities where manure can be procured from without, even though a waggon-load of dung should cost 2 rix-dollars. Where this facility is unattainable, the culture of beet in large quantities is attended with difficulties, because it certainly consumes a portion of the nutritive matter contained in the soil, and, if sold, yields little or no manure. When a cultivator can realize 3 groschen per quintal from his beet, by using it to feed his own live stock, he ought certainly to prefer this mode of employing his crop, in order not to diminish his supply of manure. Hence there will always be considerable difficulty in keeping large factories constantly supplied with a proper quantity of this raw material. The great question respecting the advantage of extracting sugar from beet-root cannot remain long undecided, now that establishments for the purpose have been erected in so many countries. The possibility of this mode of preparation is beyond all doubt.

The Turnip (*Brassica rapa.*)

Various kinds of turnips are cultivated: and, according to the nature of the soil and the culture bestowed upon them, perhaps also by the mixture of their pollen with that of other species, new varieties are produced almost without number. It is probably by cultivation that the varieties to which we give the preference for field-culture have acquired their present form and size, and that these properties are transmitted by seed from one generation to another, provided no degeneracy is occasioned by neglect of culture.

In a botanical point of view, some turnips appear to spring from the *Brassica rapa*, others from the *Brassica* *oleracea*, or perhaps from crossing, to which the Brassica family seem very much inclined.

In an economical point of view, turnips are chiefly distinguished into two classes, viz.: those which require to be sown where they are to grow, and will not bear transplanting (at least not without a large ball of earth adhering to them), and those which are usually transplanted, or will at least bear such treatment.

Turnips which will not bear transplanting—Turnips properly so called.

Turnips of this class are derived from the *Brassica rapa*, and are much more watery than those which will not bear transplanting. They exhibit endless diversities of form and colour. They have an enlargement in the root, which in some is large, round, more or less compact, and is shaped like an onion with a tap-root at its lower part: others have rather a fusiform root, terminating in a point at its lower extremity, and changing by degrees into a tap-root. Both varieties are sometimes white, sometimes inclining to yellow, sometimes tinged with red or green. Sometimes they stand with the greater part of their bulk above ground, sometimes below. Their size is infinitely diversified, and appears to depend chiefly on cultivation. But the disposition to attain a large size is transmitted by seed through several generations. The turnips which in England sometimes attain the weight of 60 or 70 lbs., appear to be absolutely identical with those which in our country usually weigh about ½ lb.; indeed, I have already increased the weight of some of the latter to 14 lbs. Large turnips are not indeed a particular variety; but it is, nevertheless, important to preserve their seed, when we intend to cultivate these plants.

In Germany we have long been familiar with the difference between turnips sown on the fallow-field and those which are sown on stubble-land; the former are known to grow to a much greater size. But we do not here pay the same attention to turnips sown on the fallow that they do in England, where these turnips form the principal source of food for their live stock, and are the corner-stone of their system of husbandry. In England, too, turnips are the crop usually selected to supply the place of fallowing; and the system now known by the name of alternate cultivation is also designated as *turnip cultivation*, and sometimes as the *Norfolk and Suffolk system*. For information on this system, I refer my readers to the 1st and 3rd volumes of my "English Agriculture," supposing that all who wish to adopt this mode of culture will have that work in their hands. I have nothing to add to what I have there said, excepting that the annoyance of plant-lice and caterpillars has given me a great dislike to the system.

In Germany turnips are sown on the fallow at the end of June or the beginning of July, after the land has been ploughed three times and manured.

Cultivators who are able to pull up the weeds usually do so; but rarely hoe or thin the turnips, or regulate the spaces between them. When the crop succeeds the produce is considerable, though rarely equal to that of the English hoed turnips; if it fail, the loss of the seed is disregarded. But as the culture of other plants on the fallow is more productive, we rarely sow turnips on it.

In Germany turnips are more generally raised on stubble-land. This cultivation is indeed very common in the western parts: on the banks of the Rhine it has been in use from the earliest times; but it is decreasing, and, indeed, almost disappearing in the countries north of the Elbe. This decrease cannot be attributed to the influence of climate; the crop is not usually later in these parts than in the west, neither does winter come on earlier. This culture is, however, highly advantageous, and in the countries above-mentioned constitutes one of the chief foundations of the system of agriculture. Why, then, has it been renounced in our part of the country? Chiefly because in large rural establishments there is such a press of business during harvest time, that it is difficult to break up the stubble after the first rye crops have been carried, which is an essential condition of this method of culture. In our large establishments the rent of land is usually of less amount than the cost of labour; and as turnips sown after harvest require cultivation, we prefer sowing them on the fallow, where their success is less precarious, and their cultivation takes place at a more convenient season. As to our smaller farmers, they are usually too poor to undertake this labour; and, moreover, they are without examples of this cultivation, which is, nevertheless, better suited to them than to establishments of larger extent.

Turnips require a sandy soil mixed with clay, rich, and neither very dry nor exposed to excess of moisture. For turnips sown after harvest (and it is of these alone that I am now speaking) the stubble is ploughed superficially as soon as the rye is cut; this labour is often not deferred till the corn is housed, but the plough is passed between the stooks of grain. A strong harrowing is then given, and the stubble thus uprooted is collected with the rake and burned. When manure is to be had, it is put upon the land; this, indeed, is indispensable, if the soil has not been previously manured for the rye crop. Soon afterwards the plough is again used, more deeply; then the ground is harrowed, and the seed sown as regularly as possible, the quantity used being about 1 lb. or $1\frac{1}{4}$ lb. per acre; finally, the soil is once more harrowed, and then rolled. The turnips are sometimes sown after the first ploughing, especially when the soil is very sandy; but they do not succeed so well as those which have received more efficient preparation. The sowing must be performed as early as possible, that the soil may not have time to dry.

When the turnips have put forth their leaves and taken root firmly, they are well harrowed. No notice is taken of the uprooting of a few weakly plants by this operation; the loss of these is, indeed, favourable to the growth of the rest. Wherever harrowing is adopted, it is regarded as indispensable to the production of a good crop. Those who cultivate but a small extent of ground, and take great pains with it, have the larger weeds pulled up.

The success of the crop is altogether dependent on a fall of rain soon after sowing. When the latter part of the summer is dry, the sowing turns out a complete failure, the young plants being destroyed by aphides. The loss of the seed is, however, of no consequence, and the labour bestowed on the soil is beneficial to the following crop. Caterpillars are less dangerous to late than to early-sown turnips; they may be destroyed by means of the harrow and roller.

When the turnips are too thick, the smaller ones are pulled up about Michaelmas, and may, together with their leaves, be profitably given to cattle. The larger ones are left in the ground till November; they are then gathered, and the necessary quantity of them is given to the live stock, the leaves not being cut off; the remainder are stripped of their leaves, and stored up in cellars, or in heaps covered with straw.

If it be impossible to house the whole crop, part of it is left in the ground; the larger turnips only being taken up. With us, they are most commonly left in the ground during winter; and in spring, with their young shoots, they afford excellent feed for sheep. Sometimes also they are fed off by sheep on the ground, especially when they have not attained a very great size, or the requisite amount of labour cannot be bestowed upon them. But in winters, during which there is a rapid alternation of frost and thaw, turnips are sure to perish in the ground; hence it is always desirable to house as many of them as possible.

It is not uncommon to obtain a crop of 20 or 25 quintals per acre. On land which has been manured expressly for the crop I have known the quantity to amount to 40 quintals.

Sometimes, when turnips have been gathered in December, autumn-rye is sown upon the land; but the soil is more commonly devoted to spring-grain, for the growth of which it is well prepared.

The nourishment afforded to the soil by the turnips left in it, and their young leaves, is, perhaps, an equivalent for that consumed by the rest. It is said that this method does not impoverish the land.

Turnips are not very nutritious in proportion to their bulk; but they furnish agreeable and wholesome food for sheep and horned cattle. It has sometimes been thought that turnips have given an unpleasant flavour to the milk of animals fed upon them; but this must have arisen from a decayed state of the turnips themselves, or their leaves; otherwise the butter made with such milk has a flavour equal to that made from the milk of cows fed upon grass. Turnips seem to be adapted to increase the quantity of milk rather than of fat, though in England great numbers of cattle are fattened on them. It is reckoned that an ox should have per day a third of his weight of turnips. For the feed of cows, I consider 100 lbs. of turnips equivalent to 22 lbs. of hay. The very large English turnips contain a smaller quantity of nutriment in the same weight.

There is a variety of this vegetable called the *stubble* turnip: it is closely allied to the common turnip both in its nature and mode of cultivation. It is sometimes sown on rye-stubble, but more frequently on the fallow. The smallness of these turnips renders them too costly to allow them to be used for feeding cattle; but they are in request as an agreeable dish, and fetch a high price. The cultivation of these turnips is very profitable to the small farmer, who cultivates them with the help of his family, and cleans them for sale; but they are proportionably disadvantageous to the large proprietor; it has not even been found advantageous to raise them for home consumption. It is not true that these turnips require a peculiar kind of soil, to be met with in certain localities only; every clayey sand which is light, clean, and well stored with old nutritive matter, agrees with them perfectly well.

Turnip-seed should not be gathered from plants which have been in the ground all the winter, and flowered early in spring; at all events, this should not be done many times in succession; for the turnips will then become smaller and smaller, and ultimately quite insignificant in size; so that, like rape cultivated for the extraction of oil, they will soon acquire a mere cylindrical root. On the other hand, the disposition to produce large turnips is transmitted through the seed when, in addition to other favourable circumstances, it is collected from turnips of the largest size, which have been chosen for the purpose, preserved from cold in winter in pits or cellars, and replanted in spring. It has, however, been observed that turnips raised from such seed are peculiarly sensitive of frost; and in England, as this disposition is regarded with considerable apprehension, the seed is from time to time collected from turnips which have been sown late in the season, and passed the winter in the ground, after having been carefully hoed.

Attempts have also been made to sow turnips with late tares, the latter having been sown in drills and harrowed, and then cut in the green state. It is said that the turnips being thus cleared of weeds yield a good crop. This may have happened in one or two instances when the tares have been accidentally destroyed by an early frost; otherwise I should fear that tares cut while young would shoot up again too strongly to leave the necessary room for the turnips. Buck-wheat would be better adapted than tares for this purpose.

Turnips admitting of Transplantation.
The Turnip-Cabbage.

This is a descendant of the *brassica oleracea;* botanists distinguish by the name of *napo brassica* that particular variety which forms its root under ground, and is usually cultivated on an extensive scale.

This variety itself is divided into several sub-varieties; it might, indeed, be possible to produce varieties out of number, by selecting the seed of plants which exhibit peculiar characters. The several varieties are distinguished by their colour, which in some is perfectly white, and in others yellowish. The colour is, however, not always permanent; so that yellowish plants are often produced from seed taken from a white one, and *vice versa*. They differ also in substance: some are firm and compact; others soft and spongy. These latter qualities are more permanent; they continue the same even when the colour changes. The several varieties are also distinguished by external appearance by their base and their stem, so that they may be recognised at a glance. These differences, however, scarcely admit of verbal explanation, for they exist not in kind but in degree.

The kind of turnip so much prized in England under the name of *Swedish turnip* or *rutabaga*, and extensively cultivated in Germany, is also a variety of the same species; its character can be distinguished only by sight or taste.

Turnips of this description require a soil more argillaceous than that which is most congenial to turnips properly so called, viz., those which do not admit of transplantation. This is particularly the case with the heavier varieties, which are usually white. On a dry sandy soil, they remain small, and yield but a scanty produce. The more porous kinds thrive better on a sandy soil; but the one which accommodates itself best to such land is the Swedish turnip. The advantage of this plant mainly consists in its thriving on such a soil, and, moreover, attaining a considerable size; we must, however, observe in addition that it is sweeter and more agreeable to the taste than the other varieties. Otherwise, I do not think that it is so nutritious as the more compact and usually white variety, though the latter is too hard to be used for domestic purposes. For strong land, I should recommend the cultivation of this variety, but on light land, that of the rutabaga, because it yields a larger produce.

Many gardeners have maintained that the rutabaga is identical with the yellow turnip-cabbage, which has been so long known; but the former is distinguished by its taste, and, in an economical point of view, chiefly by thriving on sandy soils, and resisting frost well; whereas the yellow turnip-cabbage is the most delicate of all plants of this kind.

The mode of cultivation is the same for all these varieties. When the soil is not already well stored with nutriment, it must be strongly manured, and the dung well mixed by two ploughings at the least.

The seed is sown either on the spot where the plants are to attain their full growth, or in seed-beds, from which they are afterwards to be removed to the place prepared for them: they bear transplanting very well. In the former case the sowing takes place from the middle of May to the middle, or, if necessary, to the end, of June. It is not advisable to sow earlier, for the plants will then be inclined to run to seed in autumn, and the roots to become woody.* If, however, transplanting be preferred, it is better to sow as early as April, for the plants are much retarded by transplantation. They thrive particularly well when sown or planted on ridges, but it is then somewhat more difficult to keep them clear of weeds. In other cases, they are cultivated with the horse-hoe, and afterwards earthed up, but only to a slight extent; otherwise, the mould would cover their leaves. Towards the middle of September they may be stripped of their leaves, and will thus yield an abundant supply of fodder.

Turnips of this class, especially the rutabagas, are more capable than the others of resisting the effects of cold; the best mode of keeping them would be to leave them in the ground after it had been well drained, were it not that they show themselves above the surface, and are in consequence very liable, when left in the field, to be taken up by men, or devoured by animals, both wild and domestic.

* I know not how to designate in any other manner the state which the turnips assume when the formation of hollow cells takes place, and the diminution of fluid matter causes the fibres to become more closely packed. Our peasants denote this state by the epithet *coriace*.—French Trans.

When they are kept in store-houses, or in heaps, there is more fear of their becoming heated and putrefying, than of their being injured by frost. They are not easily destroyed by cold: they still continue good after a thaw, though they are certainly more sensible to cold in this state than when left in the ground with all their roots; and, to a certain extent, continuing to vegetate. When collected in pits or cellars, they are very likely to rot.

That portion of the crop which remains unconsumed at the beginning of the new year may be most advantageously deposited in barns or store-houses, arranged in layers separated by straw: there will then be no fear of injury from frost.

The produce of those varieties of the turnip which bear transplanting, and especially of the Swedish variety, is, when no accidents interfere with it, greater perhaps than that of any other vegetable of this description. I have myself gathered from land not perfectly manured, as much as 240 scheffels (full measure) per acre: the weight of this is about 24,000 lbs., exclusive of the leaves. But I have also met with frequent failures in the culture of these turnips, and have seen them injured by plant-lice, by the caterpillar which attacks the cabbage, and also by that which attacks rye. The last-mentioned insect is particularly fond of this plant; and, in 1810, in consequence of the drought which took place at the end of the summer, it attacked all the plants of this description. The attacks of insects render the cultivation of these vegetables much more precarious than that of potatoes or beet.

According to the analyses of Einhof, the quantity of nutriment in the Swedish turnip is, to that of the common turnip, as 15 to 12, a result which is in accordance with those of experiments made on the fattening of cattle with these vegetables: compared with that of potatoes it is as 15 to 25.

Plants of this class are eaten with avidity by cattle of all kinds, and have great influence on the secretion of milk. When not in a state of putrefaction they do not impart an unpleasant flavour to the milk.

These considerations speak loudly in favour of the cultivation of the vegetables under consideration, provided, however, we do not place our whole reliance upon them; for it must be remembered that they are liable to accidents.

The turnip-cabbage, distinguished in botanical language by the name of *Brassica oleracea*; var. *gongylades*, also belongs to the same family. Several varieties of it are cultivated in gardens: it is better adapted for culinary purposes than to furnish food for live-stock. Some persons recommend its cultivation as a field crop for this latter purpose, because it is easily gathered and cleaned during winter, its turnip being wholly formed above ground. I have seen a variety whose turnip was more cylindrical, some of the plants bearing small heads of cabbage. This must certainly have been a cross between the common cabbage and the turnip cabbage.

With regard to cultivation this plant does not differ from those already spoken of; but it requires a strong soil, well manured, and particularly well cultivated; the same kind of soil, in short, as that required for cabbages.

Common Red and White Cabbage (*Brassica oleracea*; var. *Capitata*).

There are several varieties of this plant: I do not here speak of those which are cultivated in gardens, but of the common smooth cabbage. This latter also exhibits considerable diversity in form, size, and colour: it is either white, red, or tinged with a mixture of both colours: in shape it is sometimes flattened, sometimes tapering to a point: in the latter case it is called the *sugar-loaf cabbage*. There are some kinds of cabbage which, when cultivated on a proper soil and with due attention, will form heads weighing from 20 to 30 lbs.: it is said, indeed, that their weight sometimes amounts to 80 lbs. Other kinds, and particularly the sugar-loaf cabbage, seldom weigh more than 3 or 4 lbs.; though some heads may attain the weight of 6 or 7 lbs. Many persons look upon those kinds of cabbage which grow to a large size as highly advantageous, and are even at a loss to imagine why cultivators in general rest contented with the smaller kinds. But any one who is practically acquainted with the two varieties, and examines them with due consideration, will certainly give the preference to the smaller. The large cabbage not only requires a very rich soil, but a proper regulation of the interspaces, to the width of four feet in all directions for the very largest, and three feet for the next in size: consequently, only nine plants of the former and sixteen of the latter can be grown on a square perch. The small variety, particularly the sugar-loaf cabbage, succeeds admirably well in rows placed at intervals of two feet, the plants being set six inches apart in the rows; so that 54 plants grow on a square perch. It is almost sure to attain its full development, while the other often remains weak and sickly: it also becomes more compact, and is more easily preserved. As cabbage plants, even when treated with the greatest care and in a state of active vegetation, are liable to be destroyed by the larvæ of the cockchafer and the mole cricket, there remains a large vacant space on the ground when a plant of the larger variety disappears from this cause; whereas, among those which are planted at small distances, the loss of an individual plant is scarcely noticed.

The cabbage requires a clayey soil in excellent condition, or well impregnated with humus, and in a damp situation. This argillaceous soil must be carefully and repeatedly mingled with warm and active manures; and, if possible, before the last ploughing, sheep should be penned on it, or it should be watered with drainings from the stable. But even rich soils well supplied with humus, require manuring before they are used for raising cabbages; the manure is, however, intended to act rather as a solvent than as a source of nourishment. In treating of the culture of hoed crops in general, we have said all that is necessary on the rearing and transplantation of the seedlings. Cabbages may also be sown on the spot which they are to occupy during the whole time of their growth, the supernumerary plants being removed by hoeing: but this method is scarcely practicable excepting on very clean land. Great care must be taken to raise the seedlings in good time, so that the transplanting may be performed in May, during favourable weather.

Cabbages must be cultivated with the horse-hoe, and then earthed up at different times, until their leaves cover the whole surface of the ground. It is sometimes necessary to cultivate the soil quite close to the plants, and destroy weeds with the hand-hoe.

The cabbage may without injury be stripped of its leaves as soon as it begins to shed them, but not before. When this has been done, it is useful to earth it up again; new leaves will then be put forth.

The heads are plucked or cut towards the end of October; sometimes even later. If, however, in consequence of wet weather, they should begin to break, the gathering must take place earlier in the season. The stump is left standing together with the outer leaves, or the stem, which are afterwards taken as they are wanted to feed the cattle. When there is a great abundance of these stumps, they may be consumed on the ground by the cattle.

There is perhaps no other plant whose produce is so great as that of the cabbage when grown on a soil adapted to its nature. Crops have been obtained of which the heads alone weighed more than 500 quintals per acre: 300 quintals per acre is by no means extraordinary. The cabbage is usually cultivated for sale, and may indeed be sold to great advantage by cultivators who possess land well suited to its growth, and situated in countries where it is not abundant. But the cabbage may also be advantageously cultivated solely as food for cattle, provided the soil be well-adapted to it; notwithstanding that six quintals of cabbage are required to furnish as much nutriment as one quintal of hay, or two quintals of potatoes. When given in abundance, cabbages are well adapted for fattening cattle of all kinds, and produce large quantities of milk. If the rotten leaves be thrown away, milk and butter thus produced will have a pleasant grassy flavour. Cabbages are considered very useful for ewes which have lambed.

According to the mean of my experiments, an ox which is being fattened consumes (per day) from 150 to 180 lbs. of cabbages; a sheep, 12 lbs.

But the cabbage is very difficult to preserve during winter. For even when, by exposure in the open field, it has been attacked by frost in all its parts, and is yet not spoiled when the thaw comes on, it nevertheless suffers considerable loss by the rotting of its outer leaves. It cannot be kept in cellars or warm places, for it soon rots there. The best mode is to leave it on its stem, to be taken when wanted; endeavouring, however, to have it consumed in the early part of the winter. Making it into *saur kraut* for cattle is a very good plan, but very tedious, and incapable of application on a large scale.

The cabbage is exposed to various accidents: to plant-lice in its infancy: to honey-dew; after which it is again attacked by another species of plant-lice: to worms which attack its roots: and to caterpillars which attach themselves to its leaves and devour them, sometimes completely destroying the plant. These various enemies do not, however, wage war upon it to so great an extent in the open field as in gardens.

Carrots.

The culture of this plant for feeding cattle is practised not only in England and Belgium, but also in various parts of Germany, and acknowledged to be very advantageous, provided the necessary care and labour can be bestowed upon it. The care required is, however, greater than that which is requisite for any other plant of this kind.

There are several varieties of the carrot, but they are distinguished from one another merely by size and colour. The smaller kinds, usually sown in gardens or hot-beds for the sake of obtaining an early crop, are not looked upon as well adapted for the purposes of agriculture; for which, on the contrary, those varieties are most in request which are disposed to grow very thick and long. Some carrots are of an orange colour; others of a pale yellow: the largest that I have seen have been of the latter kind.

Carrots require a light, and therefore a sandy, soil; but it must be fertile to the depth of at least a foot. When this latter condition is fulfilled, carrots will thrive very well, even though the field should be cut off from all access of moisture.

A soil of this description requires no further cultivation with the plough. If it has been once ploughed to the depth of a foot, an operation which cannot be better performed than with a double plough, it will be in a state of sufficient preparation. The soil must, however, be perfectly free from dog's-grass, and all other weeds which multiply by their roots. If this be not the case, the weeds must be destroyed by two or three superficial ploughings. It is for this reason that carrots are often cultivated after other weeded crops, by which the soil has been already cleaned. The deep ploughing is given and the soil completely prepared in autumn, in order that it may sink down during winter, and the seed be sown as early as possible, even before the winter is over, and while the snow remains on the ground.

If the soil be still rich in nutritive matter, it will not require manuring; but if it be exhausted, the sparing of manure is a false economy, for it will occasion a considerable diminution of the crop, even though the labour of cultivation may be the same. After sowing, a quantity of dung, either very rotten, or else tenacious and full of straw, must be spread on the soil; when the carrots spring up, the residue of this dung must be removed with the rake. Many cultivators have found this method perfectly successful.

The sowing of carrots is attended with some difficulty, for the seed is much disposed to stick together. It must, therefore, be forcibly rubbed between the hands; otherwise it will fall in lumps. But even after this trituration, the grains will sometimes remain adhering to one another: the best mode of proceeding in such a case is to mix them with wood shavings, rub them well together, and then sow them. The quantity of seed is 3½ lbs. per acre; this will certainly be sufficient if it be well spread.

The cultivation of carrots is certainly much facilitated by drilling: but I have always found this operation difficult, on account of the disposition which the seed has to stick together. The young plants thus sown grow in tufts very close together, and the thinning of them occasions a great deal of trouble.

The seed must be but very slightly covered. In wet weather, it will penetrate the ground spontaneously: in dry weather, the soil is first harrowed, then the seed is sown, and lastly, the roller is passed over the surface.

The seed remains a long time in the ground before it springs up, especially when its germination is not favoured by warm and damp weather; the young plants then grow up in a very weak state. In such a case the soil becomes covered with weeds before the plants make their appearance,* and the destruction of these weeds is absolutely necessary.

Some cultivators have succeeded in almost wholly superseding this labour by means of harrowing; but they must have been peculiarly fortunate in choosing the precise moment when the weeds could be completely destroyed by this operation, without injury to the young plants just emerging from their seed.

When the carrots show themselves by their cut leaves, it is indispensably necessary to rake, hoe, and thin them: the hoeing must be repeated twice at least. By the first operation the carrots are left somewhat too close together; but, by the second, they must be thinned till they are at

* To avoid this inconvenience, and gain more time for preparing the soil intended for the carrots, I am in the habit of spreading the seed (after it has been rubbed between the hands in the manner above described, and mixed with shavings) on a table in a warm place, but protected from the direct rays of the sun. It is then constantly watered with stable-drainings, for 8 or 10 days, in order that it may be ready to germinate as soon as it is put into the ground. To prevent the upper portion of the seed thus spread out from drying too quickly, and becoming deteriorated, instead of germinating, I cover it with a small quantity of ashes, by which means the moisture is more completely retained. I also take care to keep the seed constantly moistened up to the time when it is put into the ground, and then to cover it up.—French Trans.

least nine inches apart. It is almost incredible to what an extent the success of the carrots depends on the performance of this operation. I have repeatedly made a comparative experiment, and seen others do the same, by treating one half of a field according to the gardener's method, that is to say, first pulling up the weeds and then a portion of the carrots to thin them—and hoeing the other half at the proper time. The portion treated by this latter method yielded at least three times as much as the other. But the hoeing of carrots requires practice and attention, and therefore renders their cultivation difficult and costly.

It is, however, worth the trouble; for, by means of it, the crop of carrots may be made to amount to 300 scheffels per acre, and even more.

If it be impossible to devote so much attention to the cultivation of the carrots, we must content ourselves with smaller produce. In such a case, it is better to sow them amongst some other plant, and take them as a second crop: they are well adapted for this purpose, since they do not spread till the latter part of summer. They are usually sown among poppies, which are removed in tolerably good time. After poppies, early flax is best adapted for sowing with carrots, because, when pulled up, it leaves the soil clean and light for them. It is also said that carrots may be sown amongst rye: but if so, it must be necessary to hoe the stubble immediately after harvest, in order to remove it; and leave to the carrots a sufficiency of room and a lightened soil. This operation is required in so busy a season that I have not yet been able even to try it: if it were omitted, the carrots would certainly fail. It will be understood that carrots sown amongst other plants require a richer soil than when sown by themselves.

The leaves of carrots are cut at Michaelmas; but cattle do not like them; they even prefer potato haulm.

Carrots are best taken up with an iron fork: the leaves are usually cut with a scythe. Some persons say that they keep better when the tops are removed by twisting. It is certainly at the point of separation that carrots usually begin to rot: it is, therefore, proper to allow this part to dry and cicatrize before the carrots are taken to the store in which they are to be kept during the winter. It is advisable also to leave the carrots for a certain time on the ground, in small heaps, in order that they may be washed by rain.

Carrots are not injured by moderate frost; but, when severely attacked by it, they are very apt to rot after a thaw. On the other hand, when they are put in large heaps and kept very warm, they soon ferment and rot. It is, therefore, somewhat difficult to keep them during winter. The safest method is to place them in layers alternating with straw, either in cellars, or in stacks or heaps, which, on the approach of severe cold, are covered with straw and then with earth, in the same manner as potatoes; care must be taken to admit the air as soon as the weather becomes mild. When carrots are kept in pits, it is not safe to put more than a few bushels together.

Carrots afford excellent nourishment for all kinds of live stock. For this purpose they are better than any kind of turnip, and, according to the experience of many agriculturists, they agree very well with pigs: they are even somewhat superior to potatoes, which, nevertheless, contain a great quantity of solid food. In my part of the country, they are regarded as absolutely the best food that can be given to pigs. An anonymous writer in the "German Agricultural Gazette," has lately maintained that carrots are injurious to the formation of milk in horned cattle. It is scarcely conceivable how data assumed at hazard could produce so much effect as those of the author in question have produced. Other persons, however, relying on their own experience, have successfully refuted the assertion. Carrots *have a highly beneficial effect upon milk!*

It has long been known in our country that carrots are eagerly eaten by horses, and are very wholesome for them; in consequence of which they have been adopted as a remedy for horses which have been overheated. But, as I have observed in the first volume of my "English Agriculture," the English, and particularly the Suffolk cultivators, were the first to show that horses may be kept in full vigour for six months upon this food, although they are employed in the most laborious occupation. A horse requires 70 or 80 lbs. of carrots per day, besides 8 lbs. of hay.

The Parsnip.

This plant requires for its complete success a soil even richer and more humid than that required for the carrot. Its cultivation is almost entirely similar to that of the carrot, but somewhat easier; for the parsnip gains strength more quickly, soon puts forth its large leaves, and is not so easily choked by weeds. It is also more easily drilled, because its seed is more uniform. But it absolutely requires thinning, without which it gains but little strength.

On a rich soil well stored with humus, the produce of the parsnip surpasses even that of the carrot. In point of nutritive power these two plants are, perhaps, equal; some persons even think that the parsnip has the advantage in this respect.

An advantage which the parsnip possesses over all other root-vegetables, is that, when left in the ground, it completely withstands the attacks of frost, so that it may be kept for spring consumption. It therefore deserves more attention than it has hitherto received. Vide "Annalen des Ackerbaues," bd. iii. s. 294.

Parsnips, as well as carrots, may be sown amongst other plants.

The abundant leaves of the parsnip are very grateful to cattle, and, if I can trust the limited experiments which I have made upon this subject, increase the secretion of milk. It might, therefore, be advantageous to cultivate this plant merely for its stalks, which always grow again after being cut, and take root almost as easily as weeds.

Maize, or Indian Corn (Zea mais).

This plant belongs by its nature to the cereal grasses, and by its cultivation to hoed crops: it is for the latter reason that we treat of it in this place.

Maize requires a warm and rich soil, the former quality being requisite in proportion to the coldness of the climate in which the plant is grown. A soil which is both sandy and calcareous, and mixed with a small quantity of argillaceous matter, is better adapted for maize than a tenacious plastic clay; especially if the former be well supplied with manure. For the cultivation of this plant, the land should, if possible, slope towards the south, and be sheltered from the north-west wind. The culture of maize is much less precarious in southern climates; it may, however, succeed in ours, provided we are not frightened by failure in cold summers. In 1805, the larger variety failed altogether in this country, and the smaller scarcely attained maturity. In 1810, the cold which happened towards the end of summer caused the maize to fail.

The varieties of maize are innumerable; but they are not permanent, and easily blend one into the other. The colour of the seed is particularly changeable; but, in an economical point of view, this appears to be a matter of indifference: diversity of size is of more consequence.

The maize which is cultivated in the southern states of North America grows to an enormous size. In one experiment made with this variety, some seed was sown in a bed which was situated on the south side of a house, and had been plentifully manured for the cultivation of flowers. The maize reached, with its male flowers, the windows of the second story, a height of at least eighteen feet. It was a magnificent plant; but although the summer was tolerably warm, not a single grain ripened. This variety is, consequently, quite unfit for cultivation in our country.

The variety most frequently cultivated in Europe is that called the large maize: when successful, it yields a considerable crop. Lately we have been made acquainted with the small variety, which, under the names of *quarantino, cinquantino, sessantino,* and *torquetto,* is cultivated in Italy as a second crop. It has been recommended for cultivation in this country, because it may be sown late, completes its vegetation during the hottest season of the year, and therefore appears well adapted for cultivation in northern climates. But according to all the trials which have been made of this variety of maize, its produce is too scanty to repay the trouble of cultivating it as a separate and principal crop. It easily mixes, however, with the larger maize, and produces a hybrid variety, which appears to be the safest and best adapted for cultivation in our climate, though we must not expect it to yield a produce equal to that of the larger variety.

Maize requires a soil carefully and deeply cultivated, and having a vegetable stratum well stored with manure.

It must not be sown till we can predict with some confidence that no frosts will happen after it has come up. In this country much apprehension is with reason entertained of the dangerous days of the middle of May, and therefore the maize is sown at such a time that it cannot come up till after that season. Some persons maintain that maize is not very likely to be injured by frosts which may attack it in the first stage of its growth: for my part, I have continually seen maize-plants which have been seized by frost remain sickly, although they have not been killed.

Maize is cultivated by the gardeners' method, with great labour, and in various ways: but I here confine myself to describing the horse-hoe cultivation, the only method by which this plant can be adapted to large rural undertakings.

The seed may, like that of beans, be deposited in the row by means of a bean-drill, to which is adapted a cylinder, proportioned in size to the work which it is to execute, and the size of the maize seed: but the furrow must have very little depth, not exceeding three but afterwards hoed and thinned, so that the plants may receive a second hoe cultivation, and be slightly earthed up. The drilling machine might, however, be used for this purpose, in order to make the hoe culture practicable with horse implements. The maize is mown close to the ground: it is not easily dried, but is well adapted for use as green meat.

In these warm climates, maize is cultivated for this purpose as a second crop; in ours it would be only in summers and autumns like those of 1811 that this plant would attain sufficient strength and size when sown upon rye stubble. It might, however, succeed after a crop of colza. The success of the smaller variety would be certain. But on the fallow, or the hoed-crop field, maize would be as appropriate as any other fallow plant intended for fodder: an early green crop might also be previously raised on the same spot, if it were thought desirable to turn the land to the greatest possible account. The produce of maize as a fodder plant would probably be equal to that of many others both in quantity and quality, especially when grown on well manured sandy soils; but I am not acquainted with any exact experiments on this subject.*

HERBAGE PLANTS.

Common purple Clover. (Trefolium Pratense, var. Sativum.)

It has long been known to agriculturists that this kind of clover, which is preserved in our country only by cultivation, is different both in nature and appearance from that which grows wild in our meadows, though botanists have always regarded them as the same species. Botanists have, however, been also obliged to acknowledge this diversity, for they have noticed a difference of proportion in the structure of the several parts of these clovers.

* During the summers of 1813 and 1814, my cows in Italy were frequently fed upon green maize; and my people constantly observed a diminution in the quantity of milk, when cows previously fed on clover or lucerne were put on maize diet. Moreover, this plant is exhausting even when mown in the green state.—French Trans.

But the clover which we procure from seed likewise comprises two distinct varieties at least. The one which has been hitherto but little cultivated in our country, but is elsewhere known by the name of *green clover*, is characterized by slower vegetation, greater strength and abundance of leaves, and a larger proportion of the green parts to the flowers. It flowers later, attains greater height and strength before it ripens, and may therefore be left standing for a longer time; whereas common clover flowers more quickly, and may be mown earlier, if we do not wish to wait till it becomes hardened by perfecting its seed. I have had the former kind in my possession, but it was accidentally destroyed. I have now got a new sample, and intend to make more accurate observations on it. According to the statement of those who are acquainted with its properties, this kind of clover is very useful, especially for stall-feeding cattle, because it retains its nutritious matter longer than common clover, and grows to a larger size.

Clover is said to thrive on all soils, even those of a sandy nature, provided it be well supplied with manure. This is true; clover will grow even on soils containing eighty per cent. of sand, provided they are well stored with nutriment, ploughed deeply, and cleared of weeds, at least of the perennial species: provided also, that the land be in a low situation, or the growth of the clover be favoured by a wet summer. By careful cultivation, land of this description may be made to produce very fine clover, if the weather be not unfavourable. But on soils which contain a greater quantity of clay, and are at the same time calcareous, clover requires less careful cultivation, and in dry seasons is much less precarious. At all events, there is no reason to fear that clover grown on such soils will dry down to its very root. On a marly and vigorous soil clover is, as it were, in its native abode; nothing is required beyond the spreading of the seed: the clover gets the better of all the plants that grow around it. But on a sandy soil, totally destitute of lime, and somewhat disposed to acidity, it is necessary to remove be threshed as easily as other grain plants; those ears which are intended to furnish seed for sowing should be emptied by hand, to prevent the seed from being injured.

The straw which has been left standing must next be cut off above the root; if not wanted for any other purpose, it will furnish very excellent fodder. It is said that syrup may be prepared from the stems of maize as well as from the grain of the ear. Some say that the best mode of turning the stems to account is to reduce them to ashes, for the sake of their potash, of which they contain a considerable quantity.

The grain of maize affords very substantial nourishment. In many countries it forms the principal food of man, even without being made into bread: it is not fit for this latter purpose unless it be mixed with other grain. In some countries it is used solely for feeding cattle, and is considered to be the most efficient of all kinds of food that can be employed for fattening domestic animals of all kinds. In almost all places where it is cultivated on a small scale, its efficacy in fattening poultry is well known; it is given to the poultry either whole, macerated, cooked, or ground. The unthreshed ears are often given to pigs; maize which has not attained its full maturity may always be advantageously used in this manner.

As maize requires thinning to a certain width, it is often considered desirable to grow some other plant which rises but little above ground in the intermediate spaces. Beet is generally chosen for this purpose, and sown as soon as the maize has been earthed up. I must say, however, as the result of my own experience, that the beet which I have obtained in this manner has always been small, and has ill repaid the labour bestowed upon it. I have derived much greater advantage from sowing small haricots at the same time and in the same rows with the maize. Dr. Burger has contrived a modification of the bean-drill, which is very convenient for executing this double sowing. The box containing the seed is divided into two parts by a partition, and the cylinder has holes adapted to the size of the maize on one side, and of the beans on the other, so that the machine sows maize and haricots alternately, when these seeds are deposited in the spaces intended for them. The seed will not indeed be distributed with perfect regularity, but the plants may easily be thinned to the proper distance by the use of the hoe.

I have not thought proper to dilate largely on the culture of maize, because we have recently been furnished with two complete works on this subject, viz., the complete, ingenious, and admirable treatise of Dr. Burger—"*Ueber die Cultur und Benutzung des Mais;* Wien, 1809 ("On the Culture and Application of Maize; Vienna, 1809"); and "*Anweisung zum Anbau und zur Benutzung des Mais, besonders im Nordlichen Deutschlande und den Preussichen Staaten; nach eigenen Erfahrangen, von Hofprediger Schregel zu Schwedt*" ("Directions concerning the Culture and Application of Maize, particularly in Northern Germany and the Prussian States; compiled from personal experience, by Schregel, Court-chaplain of Schwedt"). The latter work has been printed both in the ninth volume of the *Annalen des Ackerbaues*, and likewise separately (Berlin, 1809). I take it for granted that every one who wishes to devote himself in earnest to the cultivation of maize will avail himself of one or other of these treatises.

Doubtless, however, in these, as in all other special treatises, the subject is exhibited on its fair side only, the chapter of accidents being left in the dark.

The use of unripe maize for the manufacture of sugar has lately been again recommended on the ground that maize is better adapted for this purpose than beet-root. I have long been of opinion that of all plants which can be raised in this country, maize is best suited to the purpose in question; the syrup extracted from it is, before crystallization, decidedly superior to that of beet-root.

In the south of France, and in Italy, maize is also cultivated as a fodder plant, and either given to the cattle in the green state, or made into hay, just as the tufted pistils begin to show themselves. It is sown broadcast, any obstacles that may present themselves, sow the clover after recent manuring, and especially to favour the extension of the roots by deep ploughings, in order that the plant may be less exposed to injury from the desiccation of the surface.

In consequence of these circumstances the cultivation of clover is in some countries very easy, and may be made to occupy any place that may be desired in the rotation. There are localities, though they are seldom met with in Germany, where clover may take the place of the fallow every three years, and will leave the soil clean and light. But in most situations clover requires a select and well-prepared spot; and it is really worthy of such selection, on account of its great utility.

The culture of clover had long been known, and had become extended, though only in isolated inclosures or gardens, when *Gugenmus*, and *Schubart, of Kleefeld*, among others, recommended its extension over whole fields, and its mixture with the cereal grasses. Since that time clover has been regarded and used by many persons as the basis of agriculture, and the pivot on which it should turn; but with various results, according to the nature of the soil, and, perhaps, also of the climate. The greater number of cultivators were for a while obliged to confine themselves to the practice of now and then turning the fallow-field to account, by means of this cultivation. Others were compelled to abandon it altogether, or at least to fallow after their clover, before they again devoted the soil to the growth of cereals, because it had become hardened and infested with herbs during the growth of the clover. Finally, the system of alternate culture has assigned to clover a place in which it is sure to succeed, even on a soil not well adapted to it, provided the weather be not extraordinarily unfavourable to it. In this place clover yields an advantageous produce, and, at the same time, maintains the soil in a favourable condition for the following crop. By labour—by the removal of weeds and the deepening of the vegetable stratum, which have been effected in the year preceding that in which the clover is sown—the soil is prepared in such a manner that the clover is enabled to cover the whole surface, and put forth its shoots without hinderance from other plants. It is only in this manner that the soil for the succeeding crop will be kept clean and light as when the clover was sown.

At the present day clover is no longer sown alone, but mixed with some other plant; for it rarely yields a very large crop in the year in which it has been sown, and in the early stage of its growth it is much assisted by the protection of another plant, which may afterwards give up the ground to it. The sooner the plant with which the clover is mixed abandons the soil or is mown, the greater is the strength gained by the clover. This plant is usually sown amongst corn; formerly it was always mixed with the spring grain, but at present it is commonly mixed with the autumn grain, and in most cases with equal success, provided the sowing be performed with proper attention, and certain precautions which we shall presently notice. Clover is not sown at the same time as the autumn grain but at such a time that it may germinate after the winter season. It is sometimes sown among peas, and certainly shoots forth with great vigour among the stubble of those plants. But if the peas are soon laid, and do not ripen quickly, the clover may be completely choked by them; its growth will then be very unequal, presenting large vacant spaces here and there. We are, however, acquainted with two plants which are altogether favourable to clover sown among them, and likewise to other plants possessing a certain degree of affinity with it; these are flax and buck-wheat. These plants favour the germination and early growth of the clover, and allow it, much better than corn, to thicken and establish itself uniformly on the land.

Flax is no longer sown, excepting on rich and well-prepared soils; it is cleared of weeds, an operation which is productive of benefit to the clover. The latter is not injured by the pulling up of the flax, if this operation be performed with proper care. But amongst buck-wheat I have seen clover growing thickly even on a soil which was not well suited to it. Close by its side, and on a somewhat better soil, there was a crop of oats growing mixed with clover; and thus I had an opportunity of convincing myself in the most positive manner of the great difference between the two crops of clover, and the superiority of that which grew amongst the buck-wheat; this superiority was maintained during the whole of the following year. I would, therefore, recommend the cultivator who wishes to have a thick crop of clover, and does not think his land very well adapted to it, to sow his clover amongst buck-wheat. It appears to be indifferent whether the buck-wheat be allowed to ripen, or mown to be consumed as green-meat. Clover also thrives well among colza.

Clover may be sown from the beginning of spring (or even in winter, provided that it do not germinate) till the beginning of August. If it be sown later, and come up before the end of autumn, it is commonly destroyed by the winter. It is particularly important to obtain favourable weather for sowing, so that not only the grain may germinate, but likewise the young plants may not be in danger of perishing from drought, or the attacks of aphides. For these reasons, the surest clover-sowings are those which are executed very early in the season, or else amongst the autumn grain, on even ground not exposed to be flooded, and even while the land is covered with snow (the melting of which carries the seed down into the ground), or amongst large barley sown very early, for the clover is then benefited by the humidity of winter. If the soil has but just sufficient moisture to enable the seed to germinate, and this moisture be then exhausted by long-continued drought, no rain coming to the assistance of the clover, and the plants are in consequence unable to gain strength, the crop is almost sure to suffer. It would be safer to sow it on a perfectly dry surface, where it might remain without germinating till wet weather came on.

The degree of care required in sowing clover depends greatly on the adaptation of the soil for it. On a favourable soil, the seed may be scattered in any way whatever; the clover is sure to come up. But if the soil be not of the proper character, we must be very careful in sowing, and not allow ourselves to be guided by the opinion of a few fortunate cultivators of clover, who think that care and attention are quite unnecessary. It may occasionally happen that a sowing performed in a very unequal manner may be especially favoured by fine weather; but at other times this unequal sowing will be productive of a great deal of mischief, which will more than counterbalance any good that may occasionally result from it.

Clover seed must not be buried under a thick layer of mould, but placed permanently in contact with a stratum of light soil. When the soil is lightened, and the seed covered up with the harrow, part of it becomes buried to too great a depth, and is choked by the earth which covers it; it should, therefore, be well spread after harrowing. Even when the crop, among which the clover is to be sown, has already grown up to some height, and especially if it be an autumn grain, the ground must be harrowed before sowing the clover, in order that the crust on the surface may be completely broken, and the cracks which are formed in it may be closed up. The clover is then sown without delay; and if it be desired to proceed without chance of failure, the roller is passed over it. In this manner the clover falls into the furrows made by the teeth of the harrow, and is afterwards covered up with a light stratum of earth, which the roller compresses upon it. The same method is pursued when clover is sown as soon as the grain of the corn crop has been put into the ground; and even if it would not otherwise be thought necessary to pass the roller, this operation must be performed for the sake of the clover. On a very light porous soil, well filled with humus, clover must be sown before the surface has been completely levelled by the harrow; and the harrowing must be performed a second time to bury the seed. On soils of this description clover shoots up through the earth which covers it; but if left on the surface, it is unable to withstand dry weather.

Some cultivators, in sowing clover among spring-corn, wait till the latter have come up, in order that they may not be choked by the clover. This accident, however, is not likely to happen, unless the soil be particularly favourable to the growth of clover. In one instance, however, I witnessed this occurrence. The soil on which it happened was not very well adapted to clover; but it was in a low situation, and the spring of the year was very wet. The barley sown on this land had suffered so much from moisture that it would certainly have failed, even if no clover had been mixed with it.

In general, then, I should recommend that clover be sown as soon as the spring corn has been put into the ground; if it be deferred to a later period of the season, the ground will require harrowing, an operation which may be injurious to the young barley.

It is of great importance that the seed be well spread, in order that the clover may not be too thick in one place and too thin in another, or leave vacant spaces. For this purpose it is well to divide the seed into two portions, and sow one along the field and the other across, unless, indeed, we can procure a sower well practised in this kind of sowing.

There is much diversity of opinion respecting the quantity of seed required. Some persons consider 4 lbs. per acre sufficient: others recommend 10 or 12 lbs. I am aware that the former quantity is capable of producing a very thick field of clover; but only under very favourable circumstances. Even if everything has been duly prepared, and a skilful sower can be obtained, I should still recommend 6 lbs. per acre; and if these conditions are not completely fulfilled, 8 lbs.: for, whatever saving of seed may be effected on a large extent of ground, it is as nothing when compared with the disadvantage of having a field of clover scantily and unequally covered. I shall hereafter speak of the qualities which the seed ought to possess.

The clover will often appear thin at first, even though the crop among which it is sown may have been gathered. This is not of much consequence: but the clover ought to make its appearance a fortnight afterwards; or, at least, as soon as rain has penetrated the soil. If the clover come up among stubble, it will often become large enough to afford a crop. If this happen before the middle of September, we need not hesitate about mowing it. At a later part of the season, there would be danger of sudden cold, which would arrest the growth of the plant to such an extent as to leave it too weak for encountering the winter. The usual mode is to have it fed off, which may be done without injury by the horned cattle till the end of September. It may also be cropped by the sheep, but not quite close to the ground, as the animals might then attack the crown of the plant and destroy it. There is sometimes too much and sometimes too little apprehension entertained of this accident.

Clover may be destroyed by winter: it is more or less exposed to this danger in proportion as the soil is more or less adapted by nature and cultivation to its wants. On a deeply cultivated soil, clover will resist winters which are fatal to that which is sown on more superficial soils. I noticed this in the winter of 1802-3, when the frost penetrated to the depth of three feet below the surface. In the winter of 1811-12, the clover perished on all dry sandy spots, whilst it maintained its ground on humid soils: but this appeared to result from the extreme desiccation which the soil had undergone towards the end of summer, rather than from frost, which in that winter was not particularly severe. Even when the clover does not make its appearance after the cessation of frost, there is no reason to despair: but if, on the other hand, a few plants come up, and yield easily to the hand, leaving their roots behind them, there is but little hope of the crop. I have indeed observed in a manner which leaves no room for doubt that such plants will sometimes take root again, and shoot forth vigorously: but this takes place only under very favourable circumstances.

Clover is sometimes covered during winter with dung containing straw, both to give it strength, and protect it from the cold. At the present day, however, experienced cultivators do not follow this practice, because the dung often makes the clover weakly, and attracts mice, and may, therefore, be more injurious than useful. Moreover, the circumstances of a farm in general do not admit of this use of stable manure. If it be desired to help the clover a little, dirt collected in the farm-yard during winter may be put upon it, or it may be watered with liquid manure. In spring, the crop may be greatly benefited by manuring with turf, or soap boilers' ashes, or a compost prepared with lime. But the most common manure for clover consists of powdered gypsum spread upon the land when the clover begins to grow.

Harrowing in spring when the clover begins to shoot forth is a very useful operation, and will repay the expense which it occasions. The more forcibly this harrowing is performed, the greater is the benefit which it confers on the clover.

The proper time for mowing clover is when the field begins to assume a purple hue from the expansion of the flowers. If the clover be mown earlier, the crop will be considerably less, for it is at this time that the clover grows most rapidly, so much so, indeed, that a week may make a difference of one half in the amount of the produce. If the clover be mown later, the crop will be still more abundant; but the stems will be hard, the whole substance will contain a greater portion of insoluble fibrin, and the following growth will be weaker. It is only when clover is to be used for stall-feeding cattle, and forms the basis of this system of feeding, that it should be mown as soon as it will bear the scythe: the portion which has been mown early will then have time to grow again by the time when the first crop can no longer be left standing. We shall say what remains on this subject when we come to treat of the stall-feeding of cattle.

Clover may be intended to grow and be cut during one year or two. It would be useless to leave it standing for more than two years, unless it were to be used as pasturage; because, in the third year of its produce, or the fourth from its sowing, it undergoes considerable diminution, and its place is supplied by grasses. The question as to whether it should be turned to account for one year or for two, must be determined by the particular circumstances of each rural establishment, and by the time during which the clover will thrive on the soil— a point which experience alone can decide. It has been remarked that there are some lands on which clover is very fine during the first year, but dwindles remarkably in the second; while on others, it shoots more abundantly, and is thicker and more uniform in the second year than in the first. The second of these cases seems to occur on soils of which the vegetable stratum is deep, but which are not much disposed to produce grass; the first case, on the contrary, when the soil has but little depth, and is favourable to the growth of grass. Nothing, however, but extensive observation will enable us to deduce any general conclusions respecting this matter, since it is possible that in those cases from which my observations have been drawn, the culture which preceded the sowing of the clover, or some peculiarity in the weather, may have had an influence on the duration of the clover. For the present, every one must be guided by his own experience as to whether it is advisable for him to let his clover grow for one year or for two.

Clover generally yields three crops. The first is commonly the most plentiful, the second somewhat less, and the third least of all. But this rule is liable to frequent exceptions, because the strength of each shoot depends upon the weather. When a shoot continues weak in consequence of dry weather, it is the worst thing that can be done to leave it standing beyond the usual time, in the hope that it will grow more vigorously when rain comes on. It should, on the contrary, be immediately cut down, especially if there be reason to hope for more favourable weather, in order that the following shoot may be thicker and more uniform. It is rarely that three abundant crops are obtained, and still more rarely that they all fail: in most instances, the goodness of one makes up for the deficiency of the others. I have often seen the second crop surpass the first, and, on one occasion, I found the third to surpass the other two.

When clover is left standing for one year only, which practice, however, is confined to the three-field system,* only two crops are commonly obtained from it: the third is buried with the plough, and the winter corn sown upon this single ploughing. Every one knows that this third crop is a valuable enrichment for the soil, and that the autumn grain, especially wheat, thrives remarkably well on this single ploughing. But the third shoot of clover is often so considerable, especially when the others have been mown early, that it is of great use in the general economy, particularly in localities where the supply of fodder is not greater than is required, and consequently, no one is willing to sacrifice it. It is not advisable to sow autumn-grain after a third crop of clover;† it is better to substitute a crop of oats sown in the following spring. This crop is always highly successful after clover, and, according to all my experiments, equally in value to the autumn-grain.

When clover is left standing for two years, it is usual to cut it three times in the first year, and once only in the second: after that a summer-fallowing is given. If the clover be thin and the land infested with weeds, this fallowing is indispensable; but if the soil be clean and well covered, two crops may be taken and the third ploughed in; after which we may proceed in the same

* This is the case in most crop-systems in which the land is not laid down to grass, and particularly in that of Norfolk: 1, turnips; 2, barley; 3, clover; 4, wheat:—or, in ours: 1, potatoes, or other hoed crops; 2, wheat; 3, clover; 4, wheat; 5, hoed beans; 6, wheat; 7, clover; 8, wheat: also in most well arranged crop-systems.—1815. French Trans.

† In the north, certainly not; but it may be done in our country.—French Trans.

manner as when the clover is left standing for one year only. The clover must not, however, be fed off by the cattle either in the first or second year. It is scarcely necessary to add that oats succeed remarkably well after two-years' clover; and if it be desired to turn the clover to the utmost possible account, I should recommend the sowing of oats, at least on those parts of the land on which the clover has not continued very thick to the last: for such spots must be ploughed at least three times for the autumn grain, if we would not have the land infested with weeds.

Clover may either be consumed as green-meat or made into hay: it is well always to proceed with the view of making some portion of it into hay, even when it is cultivated chiefly to be used as green-meat in stall-feeding, for if there be a sufficiency under unfavourable circumstances, there must certainly be a surplus when the clover is successful. When we come to treat of stall-feeding, we shall inquire whether it is advantageous, as some persons think, to make the whole of the clover into hay, and feed the cattle on dry fodder during the summer.

There are various modes of making clover-hay: the state of the weather must determine which of them is to be preferred. In settled, fine weather, there is no better method than to leave the clover in swarth until the upper portion is dry; and then turn it over with the handle of the rake, to bring the lower part uppermost. In order that the clover may not shed its leaves, it is collected in great heaps when the dew is deposited, and then carried to the barn.

But if the season be wet, and frequent rains may be expected, the clover will take too long to dry in swarth, and even if it do not rot it will lose its flavour. In such a case, it is best to spread it after mowing, in order that it may dry more quickly, and then make it into cocks. On the morrow, after the dew is dispersed, these cocks are opened and spread, an operation which is most easily performed by hand: as the clover dries, it is collected into large cocks. If these cocks are much penetrated by rain, they must be turned over as soon as the rain has ceased, and the lower part brought to the top: this work is also performed by hand, care being taken to lay the hay down as lightly as possible, that the wind may blow through it. The cocks are made as high and narrow as possible, that the greatest possible quantity of clover may be protected from the rain, and at the same time exposed to the air. To enable the cocks to retain their upright position, it is very useful to fix small stakes in the ground, and heap the clover round them.

If any incipient fermentation or rise of temperature be perceived, the cocks must be turned and spread out. In wet weather this method is very troublesome; but it preserves the quality of the clover.

The third method is that described by F. J. Klapmeyer, in his treatise on the cultivation of clover and its relation to the growth of corn. (*Von Kleebau und dessen Verbendung met dem Getreedebau.* Riga und Leipzig, 1797.) It is commonly known by the name of Klapmeyer's method. It may be recommended particularly for adoption in very rainy weather, diversified with intervals of fine.

The first method is preferable in perfectly dry weather; the second in a season of continued rain. Klapmeyer's method is as follows:—The clover mown on the preceding day is raked into small parcels at four o'clock in the afternoon, and afterwards gathered into very large cocks, each containing several cart-loads: they should be carefully made up and well pressed. If the night be calm and warm, fermentation will set in after the lapse of four or five hours, and show itself by a smell resembling that of honey. On the following morning the interior of the heap will be very hot, and on opening it vapour will be disengaged. This is the time for spreading and turning over the clover with rakes and forks. If the sun shine, or a little wind come on, the clover will be dry enough by the afternoon for removal into the barn, or, if there be not time for that operation, it may be again made up into cocks; there will be no fear of a second fermentation.

If the night be cold, windy, or rainy, fermentation will take plaçe equally well; but more time will elapse before the heat becomes too great to permit the thrusting the hand into the heap, which is the sign by which we know that the fermentation has attained it maximum. If the wind be very high, fermentation will take place on one side and in the middle, but not on that side which is exposed to the wind. In this case, the cock must be opened, and the fermented clover spread out; it is easily recognised by its brown colour: the rest must be immediately heaped up again that it may ferment. If the fermentation should have affected a small part only in the middle, the clover may be again cocked, the green part being placed in the centre, and the brown on the outside and at the top. We must then wait till it has fermented, and spread it out again. If the portion of clover which remains green and has not fermented be very small, it is said to do no injury to the rest when the whole is carried into the barn. If it be desired, however, the green portions may be separated and left behind.

If a heavy rain should come on while the clover is in a state of fermentation, it must, nevertheless, be spread out. If the rain continue, the clover must be stirred and turned again from time to time. Then, if the rain should cease for a few hours only, the fodder will soon be dry enough for housing, because moisture will not adhere to clover thus fermented. It will not rot, even though left exposed to the rain for several weeks, provided it be not removed before it is perfectly dry: its nutritive power will, however, be diminished.

The chief advantage of this method is that the clover dries very quickly, and may be cut and housed within three days; whereas, by other methods, particularly when the crop is very abundant and the clover soft when mown, this course of operation takes at least a week. Clover which has fermented is already deprived for the most part of its internal moisture, and only requires external drying.

The properties of clover are certainly changed by fermentation: this is sufficiently proved by the sweet odour which it exhales: but it is not yet decided whether the quality is improved or deteriorated by the change. The advocates of the method assert positively that the quality of the clover is improved by it; they compare the fermentation to that of bread and to the sweating of corn, by which the substance of the grain is rendered more nourishing and easy of digestion. They say, too, that all kinds of cattle, as soon as they are accustomed to clover treated in this manner, become very partial to the taste of it, preferring it even to green clover; and that this fodder produces very rich milk and excellent butter. I cannot decide this question from my own experience: I tried the method once, but was obliged to absent myself while it was in progress; and my people, fearing that the fermentation might proceed too far, opened the cocks too soon. Since that time, the weather has always been so favourable to the making of clover-hay, that I have not been inclined to adopt this method, which is very troublesome, in preference to one that is simpler. Trials on a small scale have appeared to me too little decisive, especially with regard to the effect which this fodder produces upon cattle.

According to information which I have received from many friends whom I consider impartial judges, this method is attended with all the success which is assigned to it; particularly in Silesia, where it is very generally practised. It evidently requires great labour and attention, and when the crop is large, a considerable number of hands. In changeable weather, it is especially important to have the means of placing the hay under cover, as soon as it is sufficiently dried; for if it be alternately moistened and dried, it will be injured to an extent proportionate to the degree of its internal desiccation and the quantity of saccharine matter which has been formed within it.

Various other methods have been proposed for making clover-hay, not, however, practicable on the large scale; such as placing it on poles or hurdles under cover. I cannot, however, omit to mention a process which may sometimes be useful, though it is applicable to the large clover only, and may, perhaps, be even confined in its application to that which is raised from seed. It is as follows:—A quantity of clover is taken from the breadth, as much as can be held under the left arm, and tied up with a few of the longest stalks taken from it; the parcels so formed are set up in pairs one against the other.

It is said that clover thus treated does not spoil, even when long exposed to rain, and that it ultimately dries without alteration. This is the method adopted with buck-wheat, in countries where that plant is grown.

For what remains to be said on this subject, I refer to my remarks on the making of hay, and its preservation under sheds or in ricks.

Young clover, mown just as it is going to flower, loses about four-fifths of its weight in drying completely; that which is in a more advanced stage of growth and in full flower loses but three-quarters: but the proportion is probably somewhat affected by the more or less humid state of the atmosphere during the time of growth. On the average, we may reckon that in the state of advancement which we have noticed as proper for mowing, 100 lbs. are reduced to 22 lbs.

The produce of clover is usually estimated in dry fodder, because it is much more difficult to weigh it in the green state. There is much diversity of opinion respecting the medium produce of clover: estimates vary from 16 to 50 quintals per acre; and there is certainly an almost endless diversity, according to the nature of the soil, and the cultivation and manure bestowed upon the crop. A friend of mine weighed the quantity of fodder which he had obtained in two cuttings from an acre of clover carefully measured, and on which the clover appeared to grow as thickly and strongly as I had ever seen: he weighed this fodder in a state of perfect dryness, and tied up in bundles, and found it to amount to 37 quintals 30 lbs. The soil was not peculiarly favourable to the growth of clover, but was in a state of great fertility, and had been manured on the surface with ashes from the soap-factory. I have, therefore, reckoned 40 quintals as the highest amount of produce that an acre of clover will yield in two cuttings. Since the time of which I am speaking, I have only once seen clover superior or, perhaps, even equal to the above; but, according to the descriptions which I have heard of that which grows in the most fertile regions, in Altenbourg for example, samples are to be found which far surpass it. I have now before me a specimen of clover from that country, which, as I am assured by eye-witnesses, has not been picked out as particularly fine, but rather taken as an average sample; it is in flower, three feet high, and has twelve complete stems. The lower leaves are, in the dry state, four-fifths of an inch broad and two inches long. I admit, then, that the produce of clover in dry fodder may far exceed 40 quintals per acre; but only under extraordinary circumstances.

In the first part of this work I mentioned 2,400 lbs. per acre as the average produce of clover on a sandy clay (good barley land), provided, however, that the clover occupied an advantageous place in the rotation, and one in which the soil was in good condition. This appears to me to be the nearest approach to truth, for land of this description.

In a well-organized rural establishment, the necessary quantity of clover-seed should be obtained from the land itself, for the purchase of it would not only be very costly, but also attended with many inconveniences. It is certain, however, that the soil is impoverished by the reproduction of the seed. This effect is not very obvious, but any one who wishes to convince himself of it has only to grow clover-seed for two successive years on the same land; if he do not supply the loss thus occasioned by manuring, he will see his crops continue inferior for several years on the spot where the seed has been gathered. The impoverishing of the soil is not, however, so great as to preclude the possibility of its being richly repaid.

The seed is usually taken from the second crop; in this case the first crop is mown rather earlier than usual, in order that the second may shoot forth more quickly and flower sooner. The first crop must not, however, be taken so early as to allow the backward shoots belonging to it to grow up after the mowing, for they would then get the start of the second crop, and ripen too soon. As, however, an unfavourable state of the weather may sometimes prevent the setting of the clover, and cause it to flower without forming seed, it is advisable, for the sake of additional security, to obtain a portion of the necessary seed from the first shoot, if its flowers are observed to set particularly well. The proper setting of the seed may be judged of by compressing the flowers between the fingers; they ought to be hard and to resist compression. It is best to reserve for gathering seed a part of the field on which the clover is not thick, but uniform and free from weeds.

The ripening of the seed should be as complete as possible. Some of the flowers get the start of the rest, and their seed falls to the ground in dry weather before the others have time to ripen; this inconvenience is experienced more with the first crop when the weather is hot, than with the second. We ought never to pay so much regard to it as to mow the crop before the greater portion of the plants are ripe, for even if a portion be lost by waiting, the produce will on the whole be greater than it would be if the crop were taken before it was all ripe. We may know when the clover is ripe by pressing one of the heads between the hands till the moisture contained in it is completely exhausted; the husk may then be separated by blowing upon it, and the seeds will rest in the palm of the hand. If the seeds be of a violet colour, they are ripe; but this is rarely the case with all of them: they should be hard and convex, presenting no depressions.

Seed-clover should be mown in the dew, or at least not under a hot sun; it should be made into small cocks, and left till quite dry. It dries much more quickly than young clover. Care should be taken not to shake it in carrying, and to place it where it will be well exposed to the air, if possible, on poles, above the barn floor.

As soon as the clover is gathered in, especially if it has been housed in a state of perfect dryness, it is threshed, in order to separate the heads from the stalks on which they grow; this operation may, however, be deferred till the driest frosts of winter. The husks separated from the straw are again subjected to the flail, and the seed thus obtained from them is separated by means of a sieve. What remains on the sieve is passed through the fanner, that the empty husks may be carried away by the air, an operation which greatly facilitates the threshing of the rest. This remaining portion is then taken to the barn, and spread out, for the sake of exposing it to the air and drying it well; it is then threshed again during dry weather, and the same process repeated. This series of operations may be repeated three or four times without effecting the entire separation of the grain. This separation is accomplished much more easily when the heads are dried by artificial heat. The desiccation is usually performed in the kiln, but the seed is then very likely to burn, unless great care be taken, and the seed be not put into the kiln till the temperature is considerably lowered. If the heat be too great, the seed loses its lustre and assumes a brown tint. This colour renders clover-seed very suspicious: the purchaser should look well to it. The safest method is to place a number of tables in a chamber which can be heated, and cover them with cloths, on which the clover may be spread: the room is then to be heated strongly for some days, care being taken to guard against fire.* When the quantity of clover-seed is sufficient to furnish a year's stock in advance, the best thing that we can do is to defer the threshing till the hottest days of the summer following Such a provision is in every respect advantageous, inasmuch as clover-seed keeps perfectly well, especially before it is threshed. The clover, in its husk, is removed from the barn floor, and placed on cloths spread out in the sunshine; it is then several times stirred with a rake, after which it is again carried to the barn floor and threshed. This is the easiest mode of separating the seed.

When a large quantity of clover-seed is gathered, it may be ground in the mill, but the mill-stones must be carefully adjusted in such a manner that they may not crush the seed. It is difficult to induce millers to do this in places where the operation is not common. We may usually obtain 300lbs. of clover-seed from an acre of ground, and therefore realize a considerable sum by the sale of it, especially when we keep the seed which has been obtained in a plentiful season in order to sell it at a time when it is scarce and consequently dear. To save the trouble of threshing, many cultivators sow their clover in the husk; this method succeeds very well; the germination of the clover may indeed be retarded a little, but it will be rendered less precarious. But when clover is sown in this manner, we cannot guard against the seed being too thick in some places; and to ensure a sufficiency all over the field, it is necessary to sow twice as thickly as if the seed had been previously cleansed from its husk. The labour of threshing is undoubtedly tedious, but it is incomparably more economical than the use of so great a quantity of seed, particularly if we have the means of preserving or disposing of the surplus. The straw and chaff of clover are not nearly so valuable as young clover hay; they may, however, be usefully employed in feeding cattle.

* In our climate, in which the summer is longer, we have no occasion to resort to artificial heat for drying our seed-clovers.—FRENCH TRANS.

The observation that clover does not succeed when repeatedly grown on the same spot, is too general to admit of its being called in question. False rumours and prejudices do, indeed, spread in defiance of reason; but they do not, like this opinion, originate among several nations at once. Instances may, however, be found of clover having been sown for three or four years on the same land, and with uniform success. If now we examine the former cases with attention, we shall find that where the deterioration of the clover has been observed, the soil has been turned up to a small depth only; as, for example, in Norfolk, and in the duchies of Magdeburg, Brunswick, &c. On the other hand, where clover has been found to succeed uniformly, it has been sown in gardens, in the alternate system of four or five years, as in Belgium, for example. (Vide Schwertz, ch. ii. s. 4). In these situations the soil is once ploughed up to a considerable depth between two sowings of clover. In places where the land is manured with lime, marl, or ashes, clover is not found to fail when often grown on the same spot. Gypsum, on the contrary, which is usually so beneficial to clover, is of no further use in these cases. I content myself with stating these facts without attempting to explain them.

It has been often and warmly disputed, whether clover improves or exhausts the soil, and particularly whether it favours or injures the succeeding crop. Most persons incline to the former opinion; but it cannot be denied that many have experienced the truth of the latter. It has been positively ascertained that clover does not directly exhaust the land; for it is always observed that the success of the following crop is in proportion to the beauty and abundance of the clover, provided only that the latter has not been left to ripen and perfect its seed. The contrary would certainly happen if clover drew from the land a large portion of the nourishment by which it grows. But clover when thin and weak has a bad effect upon the soil, because it then permits the growth of weeds, particularly of dog's grass, and other grasses which have a disposition to spread. Moreover, the ground is hardened, from losing the beneficial shade of the clover, particularly when the clover in spite of its poorness is left standing for a long time, and the land which has borne it is ploughed but once. If, then, we would obtain a good result from clover, in this respect also we must omit nothing which tends to make it grow thickly and strongly. It must be sown on a rich, well-cleared soil, which has been lightened by fallowing, or the cultivation of hoed crops; the sowing must be performed with great care, and the crop mown at the proper time. The clover must then be ploughed up, when it has grown up a little after the second mowing, and long enough before seed-time to allow the soil to settle itself, and the clover-stubble to rot. If, in spite of all the care bestowed upon the clover, it should grow but poorly, in consequence of unfavourable weather, and should be partly destroyed by winter, we must content ourselves with one crop, and fallow the soil with three ploughings, succeeded by harrowing. When these rules are observed, the fertility of the soil will always be sensibly improved by the growth of clover, independently of the enrichment which it receives from the increased quantity of manure produced by the crop. Corn obtained after this plant is often finer than that which is grown upon a non-manured fallow.

White, or Dutch Clover (*Trifolium repens*).

There are various kinds of clover which bear white flowers; even that of which we have been speaking sometimes changes colour; but the name of white clover is almost always confined to the species of which we are about to treat. This species of clover is indigenous on almost all moist, clayey soils in our climate; it forms, indeed, part of the sward, and even if not perceived at first sight, it is soon discovered on closer inspection. It soon shows itself after the soil has been manured with substances congenial to its nature, such as lime, or ashes;

to such an extent, indeed, that some persons have imagined that its seed must be concealed in these substances.

Some cultivators also sow Dutch clover with the intention of mowing it; but it requires a very rich soil to cause it to grow to any considerable height. On a soil of this description, it will sometimes yield a crop equal in thickness to that of the common purple clover, and, according to some persons, preferable to the latter as a fodder plant—of better flavour, yielding more nourishment, and, above all, more conducive to the production of milk. But it yields only one crop, and does not rise much above the surface.

It is more frequently used to form pastures, and is certainly the most generally approved of all plants that are cultivated for this purpose. It is peculiarly fitted for a pasture-plant by the disposition which it has to send forth shoots, and the quickness with which its leaves are reproduced, a quality in which it surpasses the purple clover. Again, Dutch clover is not so easily choked by weeds, but exterminates them by means of its roots, which thrust their way through the soil; hence, it does not require a soil so well cleared, and may with greater facility be sown after repeated grain crops. It has also been remarked, that Dutch clover is not, like purple clover, averse to growing frequently on the same soil, although that soil may have been but superficially ploughed, a consequence, no doubt, of the plant being indigenous, and growing spontaneously in this country. Some persons have, however, observed, that on soils not very well adapted to its cultivation it thrives better when first introduced than after the land has borne it for a number of years.

Purple clover is not found to be injured when sown alternately with white clover.

Dutch clover is sown either on the autumnal sowing or among the spring corn; but the former position is better for it, because among the autumn corn it grows up more quickly, and affords good pasturage among the stubble. It is also spread over the autumnal sowings as soon as the frost is over; sometimes also sown before winter, or even while the ground is covered with snow, in order that it may be more effectually buried by the water formed when the snow melts, and may consequently germinate on the first return of spring.

The smallness of the seed of Dutch clover, and the disposition of the plant to spread, allow of its being sown much more thinly than purple clover; a much smaller quantity of seed is therefore required for a given extent of ground—2 lbs. or 2½ lbs. per acre are quite sufficient, if the seed be uniformly scattered.

The time for which Dutch clover lasts depends upon the extent to which the soil is adapted to it. Sometimes it continues for three years only from the time of sowing, and fails in the fourth. When fed off to excess by sheep, it disappears sooner still, because these animals gnaw the stem even down to the roots, which they tear up.

When the seed is to be gathered, the clover is usually mown; this operation, however, always leaves many of the heads untouched. If it be desired to obtain a large quantity of seed from a small extent of ground, it is best to have the heads gathered by women and children, either by hand or with the scissors. The result of this method will always repay the expense of the manual labour. The seed may also be gathered by means of a sack having just within its mouth a kind of iron comb, which is drawn over the clover and pulls off the heads. These heads then fall into the sack, the mouth of which is for this purpose kept open with a bow.

Many other kinds of clover have also been recommended for cultivation.

Strawberry Trefoil (*Trifolium fragiferum*).

This species is very similar to Dutch clover, both in nature and appearance: it is distinguished from the latter only by its heads, which are in the form of strawberries. It is likewise indigenous, and appears to put forth leaves even more tufted than those of Dutch clover; but we are unacquainted with any trial of it on a large scale. The species known by the name of Zigzag Trefoil (*Trifolium flexuosum*), of which there are two varieties, *alpestre* and *rubens*, has been recommended as a substitute for the common purple clover, because both varieties thrive better than common clover on a bad soil; but their produce is less abundant, and they have not the soft fleshy leaves of the meadow clover.

The Yellow Melilot (*Trifolium melilotus*), approaches more nearly to lucerne than to clover, both in culture and mode of growth: it ought, indeed, to be regarded as a substitute for the former. The variety with blue flowers has too strong a scent; the yellow-flowered has less odour; and the white less still. The latter is, consequently, preferred. It, however, imparts a slight flavour to milk and butter; but this flavour is by some persons considered as not unpleasant, and in cheese is even esteemed.

Lucerne (*Medicago sativa*).

My attention has been fixed in an especial manner on this plant, on the one hand by the great esteem in which it has been constantly held from the remotest times as the best of all fodder plants; and, on the other, by repeated attempts which I have made to cultivate it with all possible care, but which in spite of all my endeavours have produced but very indifferent results. I have not, however, confined my attention exclusively to my own experiments; I have also collected and compared the results obtained by other cultivators, and endeavoured to trace the cause of the differences between them. I have, consequently, found reason to alter my opinion more than once, as may be seen by comparing the 1st and 3rd volumes of my English Agriculture. At present, I consider myself better qualified to form a fixed and well grounded opinion.

For the culture of lucerne, the lower stratum of the soil is one, I may almost say, of more consequence than the upper. The latter may be ameliorated and enriched during the growth of the lucerne; the former increases in importance every year, in consequence of the lengthening of the fusiform or principal root of the plant. For the subsistence of lucerne, it is absolutely necessary that the soil, to the depth of at least four feet, be of the same nature as the vegetable stratum, and in accordance with the habits of the plant itself. When the successive strata of the soil vary in consistence or constituent parts, the root of the lucerne is checked, and the plant dies, or, at all events, barely vegetates. That which is most inimical to it is a stiff clay on which water rests without penetrating. There are whole districts, as well as detached spots, in the fields where this variation of strata occurs, but at a depth which has hitherto concealed it from observation: in such situations all trials of this plant are unsuccessful. It is, however, possible to mix the several lower strata of the soil by turning them up, and thus to render them fit for the culture of lucerne: but the operation must be performed to a considerable depth, at least three feet below the usual depth of ploughing; and even this is scarcely sufficient. I have often found, and my experience is confirmed by that of others, that lucerne, after having presented a remarkably good appearance until the third year of its growth, has then, instead of putting forth more abundant shoots, begun to thin and die away, notwithstanding that the greatest care has been bestowed upon it.

It is well-known that a soil, to be adapted to the culture of lucerne, must not, at any time of the year, be exposed to injury from wetness. Spots which are over subterranean springs, and those on which water stagnates at the surface, occasioned by alternate strata of pervious and impervious soil, are on this account quite unfit for the growth of lucerne. Even if such portions of land could be properly drained, they would still be inapplicable to the culture of this plant. But lucerne is also injured by water running over the surface of the soil, and either collecting there, or filtering through. Such water injures the plants either directly, or by favouring the growth of grass at the surface, which chokes and destroys the lucerne. This evil may often be somewhat lessened by draining.

The soil must also be of medium consistence. Stiff clay is quite unfit for lucerne, for only the vegetable stratum of such a soil is lightened by manuring and cultivation, and the lower stratum soon offers a resistance which is very injurious to the roots. Lucerne thrives better on a deep sandy soil, but continues weak and poor, and during drought is so much injured that its leaves fall off. The best soil for lucerne is one which is homogeneous to a considerable depth, and in which the quantity of sand is to that of clay purified by washing in any proportion between 70 : 30, and 50 : 50. But it is still more advantageous to the lucerne when part of the sand is replaced by lime, even if that substance should be found in the lower stratum only, and not in the vegetable layer. The lime must not, however, predominate, or be collected in separate layers, but mixed uniformly with the other constituents of the soil. Sainfoin grows admirably on limestone, but lucerne does not.

The former kind of land, usually called *warm land*, is universally regarded as the best for lucerne. But the soil on which this plant grows should also have a warm aspect—that is to say, it should be turned towards the east, or the south, and somewhat sheltered from the cold damp winds of the north and west. Lucerne is a native of warm climates: it there withstands continued heat better than any other plant: hence, warm dry summers, in which clover suffers most from drought, are precisely those during which lucerne grown on proper soils yields the most abundant produce.

To cultivate lucerne successfully, it is necessary to turn up the soil not only on the surface, but likewise to a considerable depth: this mode of proceeding is much less costly and difficult than random trials, which seldom yield definite results. In various localities, where the lower strata of the soil vary considerably, the culture of lucerne is always precarious. Thick crops of it are rarely obtained on such soils: vacant spaces are always found; and in those parts where the plants meet with strata which are uncongenial to them, they fall off and disappear.

Land which is to be sown with lucerne must be well prepared, ploughed as deeply as possible, and cleared of all perennial weeds; dog's-tooth grass, and all roots of grasses must be absolutely destroyed—a result which cannot be obtained more effectually than by a complete fallow, or the culture of hoed crops for two successive years. Annual weeds are not very injurious to lucerne, because they are cut down together with the crop which has been associated with it, or with the young lucerne itself, after which they disappear. Their seed must not, however, be allowed to ripen.

Before executing the labours required for lucerne, it is proper to manure the land abundantly, so that the manuring may not require repetition while the lucerne is growing.

Lucerne is sown either by itself or with another crop; the quantity of seed required is from seven to eight pounds per acre,* for the grain is much larger than that of clover. The former method was once preferred, because it gives greater facility of removing weeds, and thinning the lucerne where it looks too thick. But at the present, the latter method is almost universally adopted, because it is scarcely practicable to carry on the weeding operations on a large scale, and it has been found that the young lucerne-plants are assisted by the covering and protection which they receive from those which are associated with them. Many cultivators sow lucerne with barley, especially the late four-rowed variety; the barley is allowed to ripen. Others prefer a crop which can be mown in the green state, such as peas, tares, and various mixtures. For my part, I prefer flax and buckwheat, which I have found by trial to be most advantageous; indeed, I have observed that under these plants lucerne always grows very thickly and uniformly, and afterwards shoots with the greatest

* My experience is not exactly in accordance with that of our author respecting the quantity of seed which should be sown upon an acre. I have always found it advantageous to use 16 or 18 lbs. per acre. I admit, however, that when the soil has been turned up to the depth of four or five inches, and properly manured, and the plants consequently grow with extraordinary vigour, it is not necessary to sow so thickly.—FRENCH TRANS.

vigour. The flax must, however, be pulled up with some care and management, otherwise the young lucerne plants will be injured. Buckwheat may be either suffered to ripen or mown while in flower; but as on soils of this description it usually puts forth too many leaves to allow of its producing much seed, I prefer the latter method. Under these plants the soil becomes perfectly clean; they do not shoot a second time, but leave the ground to the lucerne at the very time when the latter is required to grow most rapidly. Towards the end of summer, and in autumn, the lucerne requires no farther attention.

Some cultivators sow purple clover among lucerne, for the purpose of procuring an abundant crop in the second year, at which time the lucerne has not yet attained its full growth. For my own part, I have found the produce of lucerne in the second year to be at least equal to that of the clover; and moreover, there is reason to fear that the latter, which at first grows in tufts, would destroy a number of the young lucerne plants. I cannot, therefore, give my approval to this method.

Many persons, on the approach of winter, cover their young lucerne with stiff dung containing straw; I do not deny the possible utility of this method in severe winters, when the ground is not covered with snow. During the winter of 1802-3, the young lucerne plants perished; but we rarely have winters so completely free from snow, or in which the frost penetrates so deeply into the ground, producing not mere cracks, but deep chasms. Moreover, a very thick covering would be required to form a sufficient protection against cold so intense as this. In the winter of 1810-11, when also the ground was not covered with snow, and the cold was very intense, the young lucerne plants were not injured. The covering of dung appears to me to render the young plants delicate, to favour the growth of weeds, and the covering of the land with grass, which is very injurious to lucerne, and also to attract mice to the fields. My advice is, therefore, to leave the young lucerne to itself for the first winter.

For the preservation of lucerne it is very important, and indeed almost indispensable, that the ground be strongly harrowed, especially in spring. This operation may also be repeated between two crops, several times in the year, when the grass roots seem inclined to establish themselves in the soil between the lucerne plants. In the spring of the first year, the harrowing must be moderately performed; but in the following year it must be executed with as much force as possible, so as, indeed, to give the land the appearance of a field completely broken up. The harrows used for this purpose must be very strong and well tempered. If there be no large harrows at hand, small ones must be several times passed in all directions. This operation does no harm to a lucerne crop which has already acquired some strength. Such a crop puts forth tufts of greater size and strength in proportion to the depth to which the soil has been broken. An old lucerne field has even been restored to its youthful vigour by having furrows traced on it with the plough at intervals of a foot.

The good effect of spreading dung upon the field is increased by this strong harrowing. Lucerne may be advantageously dunged every two years, in order to maintain it in a state of vigorous growth, but the best method is to manure it alternately with dung and mineral manures. Amongst the latter, ashes are particularly efficacious; but pounded lime, mixed with mould or turf and pulverised marl, is also very useful. Of all animal manures, the most efficacious is the dung of birds, especially of pigeons, spread very thinly over the land. It is also customary to apply liquid manure, consisting of stable-drainings mixed with water, and allowed to ferment; this kind of manure is used in Switzerland, under the name of *purin*.

Gypsum spread upon lucerne produces as good an effect as it does upon clover.

Lucerne should be mown before the flower-buds show themselves, if we would ensure a prompt and vigorous after-shoot. A well managed lucerne crop may be cut four or five times in the course of a summer.

The strength of each crop increases almost every year, as long as the lucerne field continues thickly covered, and no vacant spaces show themselves, provided always that the harrowing and manuring be not neglected. Even if the old plants do not put forth shoots of equal length with those of the young ones, they have, nevertheless, the advantage in point of thickness: their produce exceeds that of all other fodder plants. Forty quintals per acre is regarded as an average quantity, but it is said that the produce often amounts to eighty quintals. The richness of the crop depends much upon the quantity of manure that has been bestowed upon it; but temperature has also considerable influence: the hotter the summer the more abundant, generally speaking, is the produce.

Lucerne is either used in the green state to feed cattle, or made into hay; the process of making lucerne-hay is the same as that for clover-hay. In the green state lucerne is most frequently given to horses; these animals gain rather than lose strength when fed upon lucerne, provided they are once a day supplied with a third of their usual feed of oats. Lucerne given to cows seems to increase their milk even more than clover; some persons, however, think that the milk thus produced is thin, and that the butter often acquires a bitter taste. I have not observed this myself.

Lucerne is a very long-lived plant. On a piece of garden ground formerly used as a lucerne-field, and afterwards turned up twice with the spade and laid down to grass, I have seen isolated lucerne plants grow up which must have been at least thirty years old. A lucerne field may often be kept up for fifteen years; seven or eight years is the time usually reckoned. Some cultivators suffer their lucerne to grow for four or five years only, not so much from fear of its perishing or diminishing, as for the sake of turning the soil to greater account by more rapid alternation.

That lucerne may be included in a well-arranged field-system, it is necessary that the system contain a great number of divisions, either to allow the lucerne to continue for a sufficient length of time, or because this plant cannot, according to general opinion, be successfully resown on the same spot till after an interval of nine years. If the number of divisions be but small, seven for example, it is best to keep a few acres of each for the growth of lucerne; to sow a portion of them with it every year; and after having gone through them all, to break up a portion every year, and devote another part of each division to the culture of lucerne. This method is particularly necessary in places where the fields are not all adapted to the growth of lucerne. In many cases particular spots of ground are devoted to this plant without regular order, being separated for the purpose from the usual rotation.

Seed is not gathered from young lucerne crops, or from such as are to be frequently cut and to last a long time, for the plants are much exhausted by perfecting their seed. I have, however, known them to be completely restored by good manuring. The seed is usually gathered on lucerne fields which are intended to be broken up; the first shoot is mown while young, and the second allowed to ripen.

Lucerne seed is more easily threshed than clover seed; but it is less plentiful, and its price is, consequently, higher by one-third.

The breaking up of an old lucerne field does not appear to me to be easy. I have treated such land with three deep ploughings, using ploughs with cutting shares, to prepare it for hoed crops, and, nevertheless, lucerne plants have sprung up again. This, however, is the case with young lucerne only; for the celebrated Pictet de Lancy, who keeps his lucerne growing for four years, only sows wheat after it, as after clover upon a single ploughing.

The fertility of a broken lucerne field is very great, especially if it has been often manured during the growth of the lucerne; such land will bear a series of crops without requiring fresh manure.

I must here notice a few particular modes of cultivating lucerne, of which I have treated more at length in the first volume of my "English Agriculture."

By transplantation, wherein the lucerne loses its tap-root, this plant may be cultivated on soils which have but little depth, because it then puts forth lateral roots which require considerable space. This seems to be the principal motive for adopting this method. I have tried it on a small scale, but have found it to be attended with this inconvenience, that the plants which grew very strongly became gradually covered with a woody envelope, hard enough to resist the scythe, and, consequently, grew higher and higher; from this cause the lucerne, after a few years, had to be mown six inches above ground. This method is also very troublesome; the transplanting must be frequently repeated, and three years elapse before the tufts of lucerne unite and press one against the other. Hence, this process has fallen into disuse in England. It may, however, be adapted for the purpose of filling up vacant spaces.

The method of drilling lucerne between grain, and in rows eight or ten inches apart, is regularly increasing in estimation in England, because the culture by which the plant is so much benefited is much more effectually performed with the horse-hoe than with the harrow. I have not yet tried this method.

A well-made lucerne ground, the extent of which is kept up by sowing a new portion every year to supply the place of that which is broken up, gives great assistance to a rural undertaking, and may even fully and safely supply the want of meadow-lands. A meadow never yields on the same extent of surface a produce equal to that of a lucerne field, and can rarely be depended upon with equal security.*

* All that our learned author has here said on the cultivation of lucerne, seems to me perfectly correct with regard to the north of Germany. But in milder climates, I have had very fine, plentiful, and durable lucerne growing on soils which had not been turned up to a greater depth than sixteen inches, but were in a healthy condition, and gravelly. I have even obtained from such lucerne-grounds, as much as eighty quintals of dry fodder per acre,

Sainfoin (*Hedysarum Onobrychis*).

This valuable fodder plant absolutely requires a soil whose lower stratum contains lime. On such a soil the assistance of a moderate quantity of manure is sufficient to ensure tolerable success to the plant, even on the poorest vegetable stratum; whereas, if lime be wanting in the lower bed, the sainfoin will not thrive, even though the richest vegetable soil should be devoted to it. On such a soil it grows up very well, and appears very thick in the first year; but it afterwards disappears without forming tufts. It requires lime or chalk: even if these substances should be in the form of hard-rocks, the roots will not fail to make their way through them. Whoever thinks of growing it may save himself a number of costly, and perhaps useless trials, by sounding his land to the depth of four feet.

Land which is to be sown with sainfoin must be cleared of weeds, especially of dog's-tooth grass, which prevents the success of this plant. The clearance may be effected by careful fallowing, or the culture of hoed crops. Sainfoin is greatly improved by recent manuring; but it is often sown on poor soils, and, nevertheless, yields a plentiful crop.

Sainfoin is usually sown with oats or barley; it is, however, sometimes sown in autumn, with corn. The seed is sown either upon or under the lines, but not at

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during the years of their greatest vigour; and I have scarcely fallen short of this quantity on rich lands which had been cultivated to the depth of the spade only; that is to say, about twelve or thirteen inches Rhine-measure.

Lucerne fields give more frequent and plentiful crops when they are watered in time of drought with warm or calcareous waters, by irrigation, or momentary inundation; but, generally speaking, their duration is shortened by this treatment, because the soil acquires an increased disposition to become covered with grass. Count Ph. Ré, formerly professor of agronomy in the university of Bologna, and now at Modena, has gone through a series of conclusive experiments on this point, in the agricultural garden of the first-mentioned university. In all cases it is of the utmost importance to take proper precautions to prevent the lucerne roots from coming in contact with stagnant and subterranean waters; but this precaution becomes doubly necessary when the lucerne-field is to be watered.—1815. FRENCH TRANS.

any considerable depth. The quantity of seed used is two or three bushels per acre; the latter quantity is to be preferred.

Sainfoin may likewise be advantageously sown in rows with the corn-drill, and cultivated with the horse-hoe, supposing that these implements have been already introduced upon the establishment; this method saves a third of the seed. When we are desirous of growing sainfoin in large quantities, we must endeavour to procure seed from countries in which this cultivation is already established on the large scale; for seed-merchants, who sell it by the pound, charge much too highly for it, and sometimes sell it in an unripe state. But we must make timely application to an enterprising and honest grower; for this grain is not a common object of commerce, and the gathering of it at the proper season requires considerable attention.

As soon as the plants have established their roots in the soil, which sometimes happens in the spring immediately following the sowing, but sometimes not till that of the next year, the sainfoin must be treated, like lucerne, with strong harrowing. If it be manured a little, from time to time, its shoots will be more abundant, and its produce large.

As this plant is usually grown on distant and hilly fields, it is more frequently made into hay than consumed as green-meat. It yields a plentiful crop just as it is beginning to flower, and a second but smaller one at the end of summer; at this time it will also afford very nourishing pasturage. A produce of eighteen or twenty quintals of hay is considered satisfactory; but on a favourable soil, frequentl manured on the surface,* the produce may amount to thirty quintals per acre. This fodder is particularly good; many practical cultiva-

* On the borders of the Lake of Geneva, where sainfoin is much esteemed, especially for feeding horses, it is often supplied with mineral manures, especially gypsum, but an opinion is entertained (and I think that I have had practical demonstration of its correctness) that animal manures cause the plant to make au effort of vegetation which hastens its death.—French Trans.

tors say that its quality surpasses that of clover and lucerne.

Sainfoin is very durable when it meets with a favourable soil, provided that it be properly harrowed and manured, especially with ashes or gypsum, and not too often required to produce seed. Fields of sainfoin have been kept in excellent condition for twenty years.

Sainfoin sometimes penetrates the ground twelve inches deep; plants of it have even been found whose roots went to the depth of sixteen inches. The roots are very strong in the upper part, so that it is not easy to break up an old sainfoin layer: this labour is, however, willingly undertaken, because a field of this description, which has previously not even repaid the expense of sowing, will afterwards yield several fine crops without fresh manuring. The light vegetable stratum, covering a calcareous rock, is thereby considerably increased, and the vigorous roots of the sainfoin appear to lighten the rock and divide the calcareous stones. It seems, however, to be matter of observation that sainfoin will not, till after a very long interval, thrive on land which it has previously occupied.

This plant, which seems to penetrate the depths of the soil to seek nourishment which it afterwards yields to the surface, is, for many countries, an invaluable gift of nature; whilst, in others, it is absolutely unavailable. Excellent fodder may, by its means, be obtained on the tops of the most barren hills, sufficient, indeed, to supply the want of low meadows. The latter may then be sometimes advantageously broken up, and thus the usual order of nature, which seems to design the valleys for producing fodder and the heights for cultivating grain, may be inverted: but we must be careful to ascertain *quid quæque ferat regio, quid ferre recuset.*

VARIOUS OTHER FODDER PLANTS, WITH PAPILIONACEOUS FLOWERS.

Attempts have been made to cultivate various other plants of the genus *medicago*, and others bearing some affinity to them, and several authors have recommended these plants; but their cultivation has no where been continued, or even generally adopted. The cause of this neglect is not so much that the plants thus recommended have been found unfit for the uses to which they were destined, as that they are, in many respects, inferior to those already spoken of; and that where the latter have been found unavailable, the former have likewise yielded but an indifferent return. Of this number are the following:—

Yellow Sickle Medick (*Medicago falcata*),

Which grows wild almost everywhere, and thrives on bad soils: its produce is, however, but small; and, on good land it is far inferior to lucerne.

Black Medick or Nonsuch (*Medicago lupulina*),

Is liable to the same objections; as are also various kinds of *Lotus;* for example, *lotus siliquosus* and *lotus corniculatus*, or common bird's-foot trefoil: various species of *Lathyrus*, viz., *lathyrus pratensis* or meadow vetchling, *lathyrus sativus*, and *lathyrus tuberosus:* several species of *Orobus*, such as *orobus niger* or black bitter vetch, *orobus sylvaticus* or wood bitter vetch, and *orobus lutæus;* also *astragalus cicer*, and various kinds of wild vetches.

All these plants are excellent in natural meadows, where they grow among the rest of the herbage. When meadows are to be sown with them, it is certainly advisable to procure the seed from other meadows in which they grow abundantly, and for this purpose to allow some portion of the plants growing in the latter to perfect their seed; but if I may rely on my own experience, these plants do not yield a satisfactory produce when separately cultivated.

Plants have also been recommended which appear very desirable on account of their strength of vegetation and the long time for which they last; but it appears to me that cattle accustomed to better nourishment, absolutely reject them. Among this number is the *galega officinalis*.

Particular attention has been directed to the discovery of a plant which shall thrive on poor and sandy soils, enable them to yield a moderate return, and at the same time improve them. According to the English, French, and Belgians, these qualities are possessed by the common furze (*ulex Europæus*). At all events, this plant is the one generally alluded to by agricultural writers who speak of furze. It grows likewise in the north of Germany, but not spontaneously; and I am not acquainted with any trial that has been made of it in our part of the country. We have, however, a very similar plant, which grows abundantly on the worst lands, viz., the common broom (*spartium scaparium*). It appears to me, indeed, very probable that this, and not the common furze, is the plant really spoken of in the works of foreign authors. Several persons have proved that broom, when properly prepared, is eaten by cattle quite as readily as furze. For an account of the excellent effects which the culture of this plant produces on sandy and heath-lands, I refer to the dissertation of Francis de Caster, in the third volume of Schwertz's "Flemish Agriculture," and various other passages of the same work; also to Arthur Young's "Tour in France," particularly the third volume. The seed of broom is sown, like that of other fodder plants, among the spring or autumn grain, and the soil is devoted to the plant for five or six years. When the broom has been cut, it is given to the cattle: the most delicate leaves are given to sheep, and the harder stalks used as manure: where fuel is scarce, these stalks are dried and used for burning. But if it be desired to make these harder stalks also fit to be eaten by cattle, they may be bruised with an instrument resembling a braque, or, what is still better, they may be reduced to a semi-fluid consistence by the bark-mill, and given to the cattle in that state. The fodder thus obtained is said to be of the most nourishing description, and to impart a most agreeable flavour even to winter butter. I have never myself tried this use of the broom; but I would recommend the trial to those who often find this plant growing wild; especially on the borders of fir woods. The use of broom is recommended by many considerations.

Corn Spurrey (*Spergula Arvensis*).

This plant is essentially different from the wild spurrey (*spergula pentandra*), both in nature and habits, but I am not aware of any characteristic mark by which the two may be distinguished; for the occurrence of ten stamens on the former and five on the latter is by no means constant, flowers with five and with ten stamens being often found in the same plant. The two species are, indeed, scarcely distinguishable excepting by their stature and time of flowering. Some persons are afraid that the cultivated species may degenerate into a weed, and, at last, multiply spontaneously; but I have doubts on this point. I have, indeed, often remarked that when spurrey ripens upon a field, it shows itself in the following year among the plants sown either upon this field or the adjoining ones. This growth arises from seed which, having been shed and dispersed by the wind, remains dormant during winter, and shoots forth in spring; but after a year or two, it disappears entirely, for the young plants are incapable of withstanding frost, whereas the wild spurrey is not injured by it.

There are two varieties of cultivated spurrey: the one rises to a small height, but grows thickly; the other attains double the height of this one, but never grows thickly or surpasses it in produce, excepting when grown on a very vigorous soil. The former is proper for the poorer soils, on which alone spurrey is usually sown; it is also better adapted for a pasture-plant. The latter variety is the more advantageous for sowing on very fertile land, with the intention of mowing it. The two varieties may be distinguished by their seed: the smaller has a black seed marked with a white ring; the larger, a brownish seed, which, when closely examined, appears spotted with yellow and dark brown, and is usually without the ring.

By mixing the two seeds, I have obtained a medium variety, which grows to a much greater height than the small kind; and, at the same time, very thickly. I have obtained excellent crops from this variety even on middling soils, and fit for either pasturage or mowing.

Spurrey grows on almost all soils, even on very bad sands, provided there be no want of water during the time of its growth: but its strength and produce vary almost infinitely, according to the quantity of nourishment contained in the soil on which it grows. It is rarely cultivated on fertile soils, but its produce is not equal to that of clover. On the other hand, it presents the great advantage of not occupying the ground long, for it may often be mown eight weeks after seed-time, unless its germination has been retarded by excessive drought. There are, therefore, cases in which spurrey may be advantageously cultivated on the best lands: many cultivators have recourse to it, when their clover fails.

Another great advantage afforded by spurrey is, that it produces plenty of seed, which is easily gathered and threshed, and therefore very cheap. When the necessary quantity is grown on the land, it may be set down at a very low price. In calculating the expense, however, we must not altogether lose sight of the fact, that spurrey, when allowed to ripen, and particularly when pulled up, exhausts the soil to a great degree; whereas, that which is mown or fed off while young, affords a very sensible increase of nutriment.

Five pounds of seed are required for an acre; but if the soil has been well prepared, and the seed be scattered with perfect uniformity, this quantity may be diminished.

The soil does not require extraordinary preparation, unless, indeed, it is infested with dog's-tooth grass. Even if this be the case, the spurrey will still grow up, but the dog's-tooth grass will soon choke it. Spurrey may be sown from the middle of May to the middle of August. In dry weather, the seed should be sown immediately after ploughing, the soil having been perfectly levelled with the harrow. The success o the crop depends altogether on the circumstance of the spurrey meeting with a well pulverised layer of earth at the surface. Hence it is better to follow the harrow by the roller, and then to harrow again: afterwards to sow the seed, and finish by once more passing the roller over it. The spurrey then rises quickly and equally, a point of great importance.

Spurrey is usually sown by itself: I have, however, seen it mixed with clover, the young plants of which were very advantageously protected and sheltered by the rapid growth of the spurrey; and, after the latter had been mown, shot up vigorously and very close together. Spurrey has also been sown with buck-wheat intended for mowing as a green-crop. It might, perhaps, be economical in some cases to sow spurrey among grain which grows up into the ear, for the sake of obtaining good pasturage on the stubble. It is often sown on the broken corn stubble, to obtain autumnal pasturage, or green-meat. At this season it is scarcely, if at all, injured by slight frosts.

Spurrey is mown while in full flower, either to be consumed as green-meat, or made into dry fodder. Its lower flowers, however, often begin to expand very early, and it is just at this time that the plant begins to vegetate most strongly; we must not, therefore, be guided by these first flowérs, when we intend to take but one cutting. If spurrey be mown while very young, it will shoot up again, and a second crop may be obtained from it, often more considerable than the first. But the first crop is scarcely worth the trouble which it occasions; it is, therefore, better in most cases to have it fed off on the ground—but quickly, and by a considerable number of cattle. The spurrey will then not be injured by this pasturage, but will afterwards shoot up with greater strength and thickness.

The produce of spurrey is, as may be conceived, subject to endless variations, not only according to the nature of the soil, but also to the state of the weather; for this plant requires heat and frequent showers. It stops growing in unfavourable weather, but quickly recovers itself when the weather again becomes congenial to it. The quantity of its produce may be estimated at the half of a crop of clover raised on the same extent of surface. When spurrey is laid up in heaps, it becomes much compressed, and undergoes considerable diminution of volume; but, at the same time, it increases in density, and a given weight of it is then much more nourishing than the same weight of any other kind of fodder, as those who cultivate it soon find out. When cattle are fed on spurrey, either green or dry, the increase of their milk and fat is sensible to the eye. Spurrey is likewise one of the best kinds of fodder for producing butter and milk of agreeable flavour.

Spurrey is easily converted into hay by making it up into small cocks as soon as it is partially dried. When the weather is fine, the plant will dry completely of itself: but in wet weather the cocks must be now and then stirred and turned over. Spurrey may be exposed to rain for a long time without spoiling or losing its nutritive qualities. The earlier it is mown, the more nutritious is the fodder which it yields: but even the straw—that is to say, the haulm of spurrey which has run to seed—appears to me to be more nourishing than any other kind of hay. It is still green when mown; for we cannot venture to let it ripen very far, for fear that it should drop its seed.

The seed may be turned to very good account, when the quantity gathered is larger than we want. Oil may be expressed from it, though not in sufficient quantity to be profitable: it is thought better to use this seed for feeding live-stock: its nutritive power has been shown to be very great. Spurrey seed, when used for this purpose, is steeped in warm water: it then loses its germinating power, swells, and becomes digestible. If not treated in this manner, it passes through the bodies of animals unchanged, and with its germinating power undiminished. When prepared as above, it is given to the cattle, either in the form of wash, or poured upon chopped straw. In cows that are fed upon it the increase of milk is visible; and it is said that the milk and butter thus produced do not acquire the unpleasant flavour which is perceptible when the animals are fed upon other oily substances. Schwertz informs us that this practice is universally adopted in Belgium.

Various other fodder plants, such as *pimpernel chiccory*, and several kinds of grasses, are best adapted for pasture grounds.

There remain, however,

The tall-growing Grasses,

which are cultivated in the fields for mowing.

These grasses may be called *Hay*, or *Stalk-grasses* in contradistinction to *Pasture* or *Leaf-grasses*, because the former have vigorous stems with strong leaves attached to them; whereas, those of the second class bear feeble and leafless stems, but have strong radical leaves, which grow with greater vigour the more they are fed off, and kept short by the teeth of animals.

Ray-grass (*Lolium perenne.*)

Of all cultivated grasses this is the most celebrated, and the one which has most steadily maintained its reputation. Two essential qualities are united in it: first, it may be mown; and, secondly, when fed off, it forms a close sward, which grows again with great vigour. It thrives on stiff, and also on sandy clays, provided they are not in very dry situations. It gives but one crop per annum, for mowing; but the fodder which it yields is very substantial when it is cut before flowering: after that, its stems become hard. The English usually sow it among purple clover, and never neglect it when the clover is intended to stand for a number of years, because the ray-grass multiplies as the clover thins. The chief advantage of this grass consists in the facility with which its seed is gathered, and the quantity which it yields. The part from which the grain is to be collected is allowed to ripen; it is then mown, and the grass is treated like corn, and threshed in a similar manner: 20 scheffels may be obtained from an acre: the quantity of seed put upon this surface is about 1 scheffel, or 1¼ scheffel. The residue of the threshing can only be looked upon as straw: but the plant shoots up again in autumn, and the exhaustion consequent upon the ripening of the seed may be repaired by manuring. In England, the most varied trials have been made with an immense number of grasses, and the result has been that the cultivation of ray-grass in the field has been continued, or, at all events, resumed.*

Common oat-like Grass (*Avena elatior*).

The plant so called by the French was at first confounded in France with the ray-grass of the English; but it is altogether different—its stems or reeds are much longer, and more thickly covered with leaves, and it does not form a close sward. Like the former, it grows on soils of all kinds, provided they are in a state of fertility, and yields as its first crop a greater quantity of hay than ray-grass: it afterwards yields a second, but weaker crop. It lasts till the fourth or fifth year, especially if it be supplied with manure.

But its cultivation is incomparably more troublesome and costly than that of ray-grass, because the unequal ripening of its seed causes great difficulty in taking the crop. It begins to ripen on the top of the panicle, and falls as soon as it is ripe; so that we cannot collect all the seed from a stem, unless we take some of it in an unripe state. There is yet greater irregularity in the ripening of the stems, so that they must be gathered almost one by one, and dried in a barn where they will be well exposed to the air. The difficulty of taking the

* The Italians, particularly the inhabitants of Lombardy, who, as well as the English, often associate ray-grass, which they call *lojezza*, with common purple clover, think that it affords, among other advantages, that of preventing distension of the stomach in ruminating animals, an accident which the carelessness of servants often brings upon cattle fed upon pure tender clover. In Italy, too, this plant often yields two or three crops in a year; and I have seen upon my own land, even in a season of extreme drought, a very good second crop of lojezza taken, with its seed perfectly ripe.—FRENCH TRANS.

crop is a great obstacle to the extended culture of this grass. It often happens that, of a quantity of seed purchased of a seedsman, not more than a fourth is ripe: and hence it becomes impossible to obtain a thick herbage, even by sowing several scheffels on an acre of ground.

Especial care must be taken to avoid confounding this grass with the *avena bulbosa,* and not to take the seed of the one for that of the other. They are much alike; but the latter species is a very troublesome weed, which continually multiplies by its bulbs.*

Tall Fescue Grass (*Festuca elatior*).

This grass is very similar to the preceding in its economic characters, but it requires a more humid soil; when it meets with such a soil, it yields a larger produce than common oat-like grass.

Its seed does not shed so easily as that of the latter; it must, however, be carefully gathered, and from each stem separately.

Cock's-foot Grass (*Dactylis glomerata*).

This plant is cultivated and used in the same manner as common oat-like grass. It must be mown very young, when it is beginning to put forth its stems, for it is only in this state that it is agreeable to cattle. As soon as its panicles are formed, the stems become hard. Moreover, if mown early, it will yield a second crop, which would otherwise be quite insignificant. The grain adheres firmly to the ear, and admits of being cut with the scythe. It is usually found amongst the seed of common oat-like grass purchased of seedsmen. Seed thus obtained often yields a larger quantity of cock's-foot than of oat-like grass.

Dog's-tail Grass (*Cynosurus cristatus*).

This is in all respects similar to the preceding, but is

* By its bulbs, and also by the numerous lateral shoots proceeding from its stem and between the bulbs, which shoots soon give birth to others; and lastly, by its seed, which ripens easily, and in considerable quantities among corn. It is, undoubtedly, one of the most detestable weeds with which a soil can be infested.—French Trans.

more inclined to harden. Both species thrive equally well on a dry but rich soil.

Common Cat's-tail or Timothy Grass (Phleum Pratense).

This grass requires a moist situation and a light soil. When mown young, it is soft and grateful to cattle; but after it has formed its ear, it becomes hard, and the hay is no longer good, excepting for horses. As it shoots late, it yields but one crop.

Cat's-tail grass produces a large quantity of seed, which does not easily shed, so that it may be mown and threshed. This seed is very small, a few pounds only being required for an acre. It is probably from this circumstance that the culture of Timothy grass has become more extended than that of any other.

The seed of this grass was first imported into Germany from England, and into England from America. The plant, however, grows wild in our country; but that imported from America appears to me to be a particular variety, for the thickest and most vigorous crop of Timothy grass that I ever saw was that of a field for which the seed had been imported from England. This was thirty years ago, and at that time the English imported this grass from America.

Woolly Soft Grass (Holcus lanatus),

Has been particularly recommended by many writers on agriculture. In my opinion, however, it is one of the worst and least agreeable to cattle of all grasses. At all events, it must be mown very young. It yields but one crop; but towards autumn it shoots up again strongly, and in tufts, so that it then furnishes a tolerably abundant pasturage, even on sandy and elevated soils, where, indeed, it is eaten by cattle, for want of better nourishment. This grass is often destroyed by frost in winter, when it grows alone, instead of being mixed in the sward with other grasses.

The seed may be collected by mowing and threshing, but it is very difficult to get the grain out of the husk.

and therefore the husk is often sown with it. In purchasing it we must be careful to notice whether the grain is separated or still in the husk: in the latter case several scheffels per acre will be required, in the former a pound will suffice, provided the seed be ripe and carefully spread.

Meadow Fox-tail Grass (Alopecurus Pratensis).

On a rich and moderately humid soil, whether consisting of sand or clay, this grass is, perhaps, the best that can be cultivated in our climate. It puts forth very thick and vigorous leaves, both from its stock and its stems; it covers the soil well, shoots forth early, and grows again very quickly, so that three crops may easily be obtained from it in the course of a year. When mown young, at the time when the ears begin to show, it is very grateful to cattle. It is not at all adapted to dry and meagre soils.

The seed should be gathered by plucking. When the grass is ripe, the ear must be taken hold of, and drawn towards the gatherer in such a manner that the husk, in passing through his hand, may separate from the grain and leave it behind. This grain must then be immediately spread out in a well-aired barn, as it will otherwise become heated, and lose its germinating power.

Meadow Grasses (Poa).

Smooth-stalked meadow grass (*Poa pratensis*); roughish meadow grass (*Poa trivialis*), and various other species of *Poa*, afford the best of all kinds of hay: meadows on which they grow are preferable to all others. But these grasses are not fit for separate cultivation, on account of the difficulty of gathering their seed and separating it from the woolly covering which keeps it united in knots, and absolutely prevents the uniform spreading of it. The *Poa* grasses, to thrive well, require a rich meadow soil.

The culture of grasses intended for mowing may be useful in certain cases; for example, when we wish to procure a fodder-field that may last for several years, and the soil is not adapted to the cultivation of lucerne, particularly if it be too damp. But this branch of husbandry can never be much extended, both on account of the difficulty of gathering the seed, and also because clover yields a larger produce, allows of alternation with the culture of grain, and prepares the soil for that cultivation. The culture of grasses should be reserved for the light, black soils of low countries, where clover often fails, and which are especially adapted to this description of plants. But soils of this nature have usually considerable inclination for the growth of herbage, and the seed of grasses that are proper for them is usually multiplied upon them to such an extent that artificial sowing is scarcely necessary. The gathering of the seed, or the very high price which it costs, and the difficulty of spreading seed of such extreme lightness in a uniform manner, are insuperable obstacles against any great extension of the culture of grasses for mowing.

We have already spoken, in the proper place, of the use of vetches, rape, colza, buck-wheat, maize, and various mixtures, both as green food for cattle, and for hay-making.

Section VI.

THE ECONOMY OF LIVE STOCK.

Under the denomination, "*economy of live stock*," we include not only the breeding and rearing of animals, but generally all that relates to their maintenance, even when not connected with breeding.

In the first volume of this work we have spoken of the necessary relations between the economy of live stock and agriculture, and the proportion which must be maintained between them. It is rare to meet with cases in which these proportions are less important; in which, for example, the necessary quantity of manure can be purchased, or cattle belonging to other parties can be taken into the establishment, either for a fixed rent, or by giving up a certain quantity of fodder to the owner of the cattle, on condition of its being consumed on the establishment itself by a certain number of cattle, and under the inspection of the proprietor. The latter method is highly convenient for the cultivator, and is adopted in many counties of England where cattle from Scotland are fattened on the farms. It is likewise common in Switzerland, where the milch cows are taken in autumn from the Alpine pastures to winter in the plains. In other countries this system is rarely pursued.

The much-disputed question as to whether the culture of grain or the economy of live stock yields the greater profit, or which of the two it is advisable to follow in preference to the other, cannot be decided on general principles. The pecuniary profit derived from the management of live stock increases or diminishes with the welfare of civilized nations, because the consumption of animal food becomes larger in proportion to the well being of the community. A large exportation of a particular kind of animal produce, in consequence of its recognised quality, may, however, cause a rise in its price; this is the case with Holstein butter and Swiss cheese. Sometimes one portion of the live stock, the value of which in other places is but small, will yield so high a profit that the price of the rest will fall proportionably low. Such, for instance, is the case in this country with sheep, which, on account of the high price of their fleeces, have been multiplied to such an extent that the market is overstocked with mutton; whereas, in England sheep are kept principally for the sake of their flesh.

In our circumstances the economy of live stock rarely yields a large profit, if we charge it with manure and pasturage at the market price. But we are usually satisfied when the expense of these matters is properly repaid by the maintenance of cattle, and our straw is converted by their excrements into an active manure. A large number of cattle maintained in this manner with great care and at considerable expense always yields an adequate return; and, generally speaking, it is observed in almost all countries that rural undertakings which maintain large numbers of cattle, and feed them well, are, in the end, more profitable than those which have only the number absolutely required, and feed them but scantily.

The advantage of one or other kind of live stock depends partly on circumstances of place and time, and partly on the skill and industry with which they are treated. In general, we may lay down as a rule for our country, that horned cattle are most profitable on low pastures, and when maintained by stall-feeding; sheep, on the contrary, on all dry and elevated pasture grounds, natural or artificial.

HORNED CATTLE.

It is not yet decided whether our domestic ox is descended from the same stock as the wild bull and buffalo. But as these animals not only breed together, but also produce a race capable of perpetuating itself, it is probable that our domestic cattle are descended from the wild race, and owe their change of form entirely to the kind of nourishment and the care which man has bestowed upon them.

But even among our own horned cattle we may observe a great diversity of races, which is transmitted from generation to generation. These changes may have been brought about by climate and mode of living; but if so, the effect must have been produced by very slow degrees, for we do not find that either of these circumstances has any prompt and marked influence on a race which is maintained in perfect purity. The choice of individuals for propagation has, in all probability, contributed most powerfully to the perpetuation of constant and distinct races, and particular varieties have subsequently been produced by crossing.

In Germany (under which title I include all the various empires and provinces in which the German, with its several dialects, constitutes the prevailing language) the races have lately been mingled in so many ways, and with so little definite purpose, that their distinguishing characteristics can no longer be recognised. We must, however, distinguish the three following races:—

(*a*). The low-country race.
(*b*). The ordinary race of the high grounds.
(*c*). The mountain race.

But these races, which are in themselves sufficiently distinct, have often been mingled.

The *low-country race*—whose distinguishing marks are a fine skin and hair, large size of body, strong bones, and short horns—is met with in several countries under different names. But it includes many varieties, each of which is distinguished by some peculiarity, especially in countries where constant attention has been paid to breeding and choice of individuals. This race probably derives its origin from the first cultivated countries of the Lower Rhine, the Elbe, the Weser, and the coast of the Baltic. It is probable that the Flemings—who, being a peaceful and industrious people, multiplied quickly, and established themselves in other low countries, in which they were readily employed to cultivate the land—introduced the race into these countries, keeping it pure in some cases, and mixing it in others to a greater or less extent with the native breed of the country. The low country breed is known in these parts by the name of the Friesland breed; it is likewise often called the Oldenburg or the Bremen breed, because it was brought to us by cattle-dealers from those countries in which it has partly been raised. The race found in the rich valleys of Holstein and Sleswick is in some respects different from the former. This is still further true with regard to the breed which has been formed in the low countries around Dantzig and Tilsitt; these races, however, resemble one another very closely. In England the same breed is known by the name of the *short-horned* or *Holderness breed*, and is thought to have been originally introduced from the Netherlands. Contrary to the opinion which has hitherto been common, I think that we ought to include in the same race the *large Swiss breeds*, of which such excellent portraits are given in the second part of the "*Deutschlands rind Viehracen*," by M. Witte, viz., the *Friburg* race, and even the smaller *Simmenthal* breed, which certainly does not belong to the primitive mountain races, although it thrives on the rich pastures at the foot of the Alps, at the same time that it is very well adapted for stall-feeding. This race has been again transplanted into some of the more fertile countries of southern Germany and Franconia, particularly the Margravate of Anspach.

These several races are all esteemed as milch cows, because, when properly fed, they give more milk than any others. But they are delicate, and require food not only in abundance, but also of particularly good quality: when badly fed, they soon degenerate, their produce diminishes, and after a short time they yield no return whatever.

The crossing of this large breed with others is not always successful, especially for the first few generations. But when the breeding is judiciously managed, the animals which are coupled not being too dissimilar, a breed may be obtained far superior to the primitive race for certain localities, and possessing its good qualities without its defects. When such a race has been obtained, it must be perfected by itself.

This race of cattle does not appear to be well adapted for draught; for, though very strong and healthy, they are not sufficiently robust and hardy for that employment; besides, their maintenance is too expensive. It is only by crossing and after a lapse of years, that strong and robust beasts of draught can be obtained from this race.

Great weight and *embonpoint* may be given to these animals by fattening: but for this purpose a large quantity of very nourishing fodder must be used; and when a beast of this description is lean, an enormous supply of food is required to fatten it again.

The native races present great diversity both on the low grounds, and on the hills. Our German breed, originally of a reddish brown colour and with large horns, has retained more or less of its size and vigour, according to the manner in which it has been treated. This race is found in its best and purest state in Vogtland: but in most places, it has greatly degenerated, for want of sufficient pasturage, and from over parsimonious treatment. It might, however, be again improved within itself, by means of better nourishment, more careful treatment, and a proper choice of individuals for breeding.

It never yields so much milk as the low country breeds: the milk is, however, on the average, of richer quality; and, in proportion to the quantity of food consumed, often yields an equivalent net return.

The hardihood of this race renders it well adapted for draught. In many countries, particular attention is paid to the rearing of oxen from it: very large and strong animals are thus obtained, which scarcely seem to spring from the same origin as the cows of this breed; which are, for the most part, very small and stunted.

In other countries the native race is strongly marked. A breed of great interest for northern Germany is that of *Jutland*, which is excellent both for milking and fattening. The hair of this breed is peculiar, of a dun or tawny colour, often spotted with white: individuals are, however, found, having black or grey hair; but a reddish brown colour is very uncommon among them; and wherever I have met with it, the form of the animal has appeared to me to betray a different origin. The bones are small, the legs short, the body long and deep, the fore-quarters proportionally weaker, the hinder large and strong. The physiognomy is peculiar: jaws thin, mouth elongated and pointed, head and neck thin. There is a feminine appearance in all these animals, even amongst the males, and this character would be yet more widely diffused, were it not that the bulls are usually chosen for breeding from another race, in which the bones are larger and the head thicker. The Jutland breed is lively and robust, and preserves its milk and flesh better than the other cattle of the country, on bad and scanty pasturage.

This race is much esteemed for fattening, because the muscular fibre is delicate and savoury; and the bones and offal weigh but little in comparison with the useful parts. The animals also readily increase in muscle and fat; though the latter substance is not developed externally so much as between the flesh and muscular fibre, where the lean and fat are so agreeably mixed. Where this meat is known, it readily fetches a somewhat higher price than other kinds. The cows, which are very lean when they begin to give milk, increase in fat when well fed, in proportion as their milk decreases; so that, at the end of their milking time, they are fat enough for killing.

As we usually obtain them, the cattle of this race are smaller than those of our ordinary German breed, either on account of the scanty nourishment which they find in their own country, or because they are paired too early. I have seen heifers brought from that country before they have borne young; and such as happened to be in a situation where they were well fed, attained great length, though they did not grow very tall. But the progeny of this race, when supplied with plenty of nourishment, may become very large: a cow of this breed, which was killed as soon as milk was no longer taken from her, yielded 550 lbs. of butcher's meat, exclusive of offal. In their own country, animals of this breed are met with which attain a remarkable length, without, however, growing tall, and give an astonishing quantity of milk: but they are not in the market. There is, perhaps, no other race which, under ordinary circumstances, is so well deserving of careful endeavours to perfect it.

Among the mountain races, that of the *Swiss Alps*, or the *Hasli* breed, is the most remarkable. M. Witte has given us an excellent drawing of it in the work already spoken of. It is indigenous in high mountain regions only; but has been naturalised in other situations, and even in Lower Saxony, originally in the countries of the Hartz. I will not, however, take upon me to decide whether the race thus transplanted may not be the less perfect breed of Schwytz, a drawing of which is to be given in the work of Witte. The Hasli race is small, but elegant and well built. The horns have a peculiar curvature directed backwards, and become very thin towards their extremities. The head is narrow, but the mouth large in proportion to it; the ears spring from thick tufts of hair; the neck is short; the legs, especially in the fore-arm, short and very thin, but furnished with very strong nerves and muscles; the foot is small and perfectly well shaped; the tail long, reaching almost to the feet, but thin, and terminated with a large tuft of hair. The body is long in proportion to the general structure, and of a fine blackish-brown colour, deepest towards the lower parts. A tawny streak, inclining more or less to whiteness, extends along the neck and back to the middle of the tail. The ears, mouth, and legs, are usually of the same colour. The eye is commonly surrounded by a tawny ring: the udder of the cow is of the same colour, and covered with hair. Sometimes the animal is also marked with white spots.

This race exhibits very little disposition to fatten; perhaps on account of the free and, in some respects, fatiguing life which the animals lead on the Alps. I have, however, seen their descendants become tolerably fat when stalled.

Cows of this breed give very good and rich milk, in proportion to their size, and the kind of pastures on which they graze: even on the Alps, however, there is a great difference between one individual and another. In our own country I have seen descendants of the race sometimes highly valuable, sometimes altogether valueless, for their quantity of milk. But I have always seen them larger here than M. Witte describes them on the Alps.

The *Tyrolese* cattle approach in some measure to the latter as regards their stature; but on the average they are much larger, and of a red brown colour. The abundance of their milk is much vaunted, and has often led to their introduction into low countries, where they thrive very well, even when stalled. Notwithstanding the expense of transporting them, they have lately been brought into our part of the country.

The *Styrian* race, at least that which is known to me by this name, is similar in form and colour to that of Hasli; but it is larger. Its colour is lighter, and the spine curved to an extraordinary degree, both in the cows and the bulls; which, moreover, are exceedingly beautiful. I must, however, confess my inability to give an exact account of the peculiarities of this breed, having seen but a small number of individuals belonging to it.

In this country we often meet with *Podolian* oxen, upon whose origin I have not yet been able to obtain exact information. They are almost all of a fine grey colour;

sometimes, though rarely, black and spotted with white. They are high on their legs, and not very long; but their breadth is considerable, especially behind in the croup. It is said that this race cannot be used as milch cows, because they will not allow themselves to be milked; but the oxen are particularly well adapted for fattening. When they are brought to us in autumn, they will have already fattened considerably on the rich pastures of Ukraine; and, in spite of the long journey which they have performed, some of them will be sure to be fat enough for killing. Others will have grown thin; but they will soon recover their fat when stalled and fed upon potatoes or hay. In this manner they may be completely fattened in 10 or 12 weeks, and their weight increased to 800 lbs.

The *Hungarian* cattle resemble the latter in colour, but are longer, and have shorter legs. Podolian oxen may be used for draught: they are usually very docile, but some of them are very vicious and cannot be broken in: moreover, they do not appear to be very robust. The Hungarian oxen are said to be better adapted for work, and more vigorous.

By the choice of individuals of a particular race, or the crossing of different races of horned cattle, families are formed, possessing characteristics of greater or less value, which, when they answer our purpose, we must endeavour to perpetuate among the families themselves. When these characters become constant, the family may be regarded as forming a distinct race. The crossing must, however, be conducted with care and circumspection. Since the greater number of cattle are reared for the sake of obtaining milk, the chief desideratum is a family of good milkers; and from this family, when obtained, we must endeavour to raise a distinct breed by always selecting the best individuals to form the nucleus of the race, and taking from among them the male and female calves to be used in perpetuating the breed. With regard to the males, most breeders are too much guided by a certain conventional beauty of form, which in many cases is not really the most desirable characteristic. When a constant race is to be formed, we must begin by coupling animals of the nearest parentage, provided they are free from defects, and adapted to the end proposed. I am now engaged in forming a breed by the crossing of the Friesland, Swiss, and Jutland races.

Breeding of Cattle.

Great care must be bestowed on the choice of the bull. With respect to form, the characteristics usually required in a bull are, that the head be short and thick; forehead broad, and wrinkled; eyes black, and lively; horns short, and dark coloured; ears long, and well placed; nostrils large; mouth black; neck short, and fleshy; chest broad, and expanding beyond the legs in front; body elongated; legs short, and shaped like columns; tail long, and well covered with hair: he should likewise have a bold and lively gait. A broad front is much valued by some persons: for my own part I prefer that the animal's hind quarters should be in good proportion to the front. First, that when he leaps the cow, he may be able to keep himself up without pressing too heavily upon her; and, secondly, because a strong croup appears to favour a large secretion of milk. I likewise prefer a bull with a long and fine head, and a thin tail: but my chief care is to select one that is the offspring of a good milch cow.

Many persons endeavour to rear bulls of great stature, by giving them a very plentiful supply of food. I am, however, of opinion that bulls may be of too great stature, so that it may be necessary to leave off using them at the very time when they attain their greatest strength, because they then become too heavy for the cows. They are often allowed to leap before they have completed their second year. This has the effect of reducing their size; but it also weakens their constitution to such a degree that they lose their generative power by the time when they have attained their sixth year, the very age at which they would otherwise be just arriving at their full vigour.

The following marks and properties are regarded as characteristic of a good breeding cow, and as justifying the expectation of a good supply of milk. The body and frame should not possess much beauty of form: the latter, descending from the spine, should grow larger towards the lower part, so as to form a large and pendulous abdomen. The general contour of the body should be rather egg-shaped than round; the rump as broad as possible, and the front narrow in proportion to it. The bones, especially those of the legs and head, should be thin: a thin tail is also a good mark. The physiognomy should be feminine—mild, but lively. The animal should be cheerful and good tempered, but bold. The udder should hang down behind between the legs; it should be large—not fleshy, but thin and soft, displaying large milk veins. A considerable hollow under the belly, deep enough to thrust the thumb into, is by many persons regarded as a sign of a good milch cow; but in my opinion this character is more deceptive than any other. A long, thin tail, reaching almost to the ground is likewise regarded as a good sign. But it is of primary importance that the cow be descended from a mother which was a good milker, healthy, and of a good stock. I have seen many good milch cows whose legs were very close together near the hams, although, as far as beauty is concerned, this conformation is not approved. Some persons require that the hinder extremity of the thigh should form a right angle with the hip bone, which projects near the tail. Moreover, the thigh should not be thick.

If we wish to produce cattle of large size, we must choose cows of considerable stature and full grown, for thickness and length of body are inherited more surely from the mother than the father. I am therefore decidedly of the same opinion as the Swiss, who endeavour to keep their bulls small, so that, in fact, the bull is often the smallest animal of the whole herd.

One bull might serve for seventy or eighty cows, if the seasons of the latter were equally distributed throughout the year; but as that is not the case, we must not reckon more than twenty-five, thirty, or forty cows to each bull, accordingly as the former require at one particular time of the year, or at different seasons. Besides, a bull might be attacked with illness that would render him unfit for leaping, and great embarrassment might thence result. It is therefore usual to keep two bulls for forty cows—a young one, in his third year, and an older one, in his fifth or sixth, so that the younger and weaker cows may be covered by the former; the older bull would be too heavy for them.

When it is our object to increase the size of a breed of cattle, we ought undoubtedly to let the heifers attain the age of three years before they breed: this is indeed always necessary when the young cattle have but scanty and inferior pasturage, and we wish to preserve the breed from degeneracy. But if the young cattle have been well fed and nurtured from their birth, we may without hesitation allow them to breed when they are nearly two years old; and I think it right to do so whenever the young heifers come to early maturity, for they will otherwise either become lean and stop growing, or, if they are still well fed, they will grow fat, and be no longer inclined to take the bull. In some countries, where the management of cattle is in other respects conducted with great care, as in the low countries of Holstein and Bremen, generation is left entirely to nature, the animals all meeting promiscuously on the same pasture. In these countries it is not uncommon for a cow to calve at the age of two years; no degeneracy of the race is apprehended in consequence; but care is taken not to milk so precocious an animal too long. I have known a cow to bear a calf at the age of eighteen months, after having been covered by a bull not older than herself; the calf continued small, but became a good milch cow.

Horned cattle come into heat at all seasons, the time being determined by that of parturition. When cows are well fed, it occurs as early as the twentieth day; but it is usually allowed to pass off, either from fear of trying the animal's strength too much, or because it is not thought proper to accelerate the time of birth. If it occurs again about the fortieth or sixtieth day after parturition, this time must not be neglected, otherwise she will probably not want the bull again. With stalled cattle it is particularly necessary to watch the signs which indicate it. These signs are restlessness, a wandering expression of the eyes and figure, extraordinary cries and lowings, swelling of the sexual organs, an inclination to leap upon the other cows, cessation, or, at all events, suspension of the lacteal secretion. The servants of the cow-house should carefully watch these signs in cows which are not allowed to go out of the stall.

When the desire of copulation does not appear, its absence is due either to weakness or to over feeding, and excess of flesh. In the first case, better food must be given; and it is thus that certain much-boasted specifics, such as oats roasted with salt, lentils, and bruised hemp-seed, produce their effect. The cow should also be made to drink the milk of another which has just come into heat. If, on the contrary, the evil arise from excess of fat, the cow must be made to take more exercise. Some breeders have restored the fecundity of their cows by yoking them to the plough.

The time when the cow comes into heat having been observed, the best time for copulation is from twelve to twenty-four hours afterwards; if it be deferred longer, impregnation will probably not be effected.

We may regard as a sign of pregnancy the fact of the cow not giving fresh signs of heat in three weeks after copulation. If, however, the cow should exhibit such signs at this time, it is by no means a sure indication that she has not been impregnated. The swelling of the abdomen is very deceptive; but after twenty weeks it becomes very perceptible, and frequently the calf may be felt on the right flank of the cow, which is not the case afterwards.

The period of gestation is usually 285 days, or forty weeks and five days. Strong, healthy cows sometimes go a week longer; if with their first calf, a week less.

When cows are in an advanced state of pregnancy, they must not, especially when stall-fed, be allowed to go out, excepting to the watering-place; care must also be taken that they are not pushed or squeezed by other cows in leaving or entering the stall.

Miscarriages, or premature deliveries, are attributed to various causes. These misfortunes may undoubtedly be brought on by fodder of bad quality, or which has acquired an unpleasant flavour. As to particular kinds of fodder, such as the straw of buckwheat, frosted cabbage-leaves, or celery-leaves, I do not think it has been proved that they cause these accidents: the opinions of those who make this assertion appear to me to be somewhat prejudiced. Abortion and unfortunate labours are, in animals as in the human race, often epidemic, and probably caused by a peculiar state of the atmosphere, for they sometimes happen in great numbers in a particular country, without our being able to point to any other cause of general influence.

Nothing can be more ill-founded than the opinion of those who pretend to facilitate calving, particularly in cows which have had difficult labours, by keeping them on short allowance during the last few weeks of their pregnancy, with the view of diminishing the size of the calf. It is not the soft fleshy parts which render parturition difficult, but the whole mass of the bones, and these are formed at an earlier period. Bad feeding deprives the cow of that strength of which she stands so much in need at the time of calving, and diminishes the quantity of her milk. On the contrary, the food given to the cow when the time of her calving is approaching, should be succulent, easy of digestion, and of small bulk, such as a mash or soup, made of crushed grain, seed, or oil cakes, or leaven of rye mixed with water: some farmers strongly recommend boiled lentils for this purpose. Messes of this description greatly forward the secretion of milk by stimulating the lacteal vessels: they are therefore very useful, both at the time of calving and for a few days after, and the more so because they enable us to diminish the quantity of dry fodder, and such as have a tendency to swell.

The signs of approaching calving are as follows:—The udder becomes distended, partially filled with milk; the generative organs swell; there are formed above the vertebræ of the tail two little hollows, which gradually increase in depth, and yield to the touch; the cow becomes restless, continually lying down and rising again; often looks towards her hinder parts, and continues lowing at intervals. She must then be supplied with a larger quantity of litter to protect the calf from injury; to a certain extent also she should be watched. In other respects everything is left to nature. Some cows bring forth standing, others lying down.

The fore-feet, on which the head rests, are the first to show themselves, and the whole body soon follows, being expelled by the efforts of the mother; it is, however, not, as with most animals, the head, but the chest which has the greatest difficulty in passing. The umbilical cord divides spontaneously; if not, it may be tied a full inch from the belly, and cut off an inch lower.

If the calf is intended to suckle, it is presented to the mother in order that she may lick it; if, on the contrary, it is to be habituated to drink milk, it is immediately to be removed to the place intended for it.

The after-birth and bladder, full of liquid, in which the calf was inclosed in its mother's body, usually come away spontaneously; to favour their expulsion it is only necessary to supply the cow with succulent food, or a mess containing starch, &c.

Calving is sometimes attended with difficulties, arising from a bad position of the calf in its mother's womb. This evil may be greatly diminished by skilful and judicious aid. The first thing to be done in such a case is to obtain an exact idea of the position in which the calf ought to be placed, and of its actual deviation from that position. By gently thrusting the hand into the womb this deviation may not only be ascertained, but, in most cases, corrected by turning the calf. The usual cause of resistance is a false position of one of the fore-legs, or of the whole body, in consequence of which the ear or forehead shows itself first, instead of the muzzle. Force must no more be applied in this case than it would be to make anything pass into the gullet; any violent traction may be fatal, whereas nature will assist if we only give her time. All assistance given must be guided by discretion; misdirected aid may do an infinite amount of mischief, and is too often fatal; this I know from experience. As, however, this is not the place for teaching the obstetric art, I pass it over, strongly recommending all farmers who pay any attention to their cattle, to avail themselves of every opportunity of acquiring information on this matter, since in the country it is not always possible to obtain the assistance of skilful veterinary surgeons. In other respects, however, it is best to leave all to nature and chance; for without proper knowledge, we shall be more likely to kill the cow and her calf than to save her:

There are two modes of nourishing and rearing the calf during the first period of its life:

(*a*). To let it suck.

(*b*). To make it drink milk.

When the former method is adopted, the mother and calf are accustomed to it from the birth of the latter, by letting the cow lick it. It is then brought, as soon as it can stand, to the udder of the cow, and immediately begins to suck. The first portion of milk possesses a purgative quality; but this is not injurious, but beneficial to the calf, for it excites the irritability of the intestines, and removes the viscous excrements which have entered them from the womb of the mother. These excrements might be very injurious to the calf if they were to remain longer in the intestines.

But there are still two methods of proceeding: the one consists in leaving the calf with its mother; the other in taking it to her as often as it ought to suck. The former is the more convenient method; but it is objectionable—first, because the calf is almost constantly playing with the udder; and secondly, because it either sucks too much, and exhausts the mother, at the same time over-feeding itself, or, on the other hand, it sucks too little, and gives rise to deposits of milk; besides, the calf is often in danger of being squeezed to death by its mother, or by a neighbouring cow. The other method, which consists in taking the calf to the mother at regular intervals; at first, four or five times a day, and afterwards only three times; care being taken each time to notice whether it has left any milk behind it, in order that the surplus, if any, may be drawn off. This method, I say, is more troublesome, requiring continued attention, in order that where there are several calves, none may be neglected; but it is safer, and more conducive both to the health of the calf and an abundant supply of milk in the cow, at the time when the calf is weaned.

After three weeks, the milk is often insufficient for the full nourishment of the calf. A kind of soup may then given to it, made of oil cake, coarse meal, bran, or ground corn; potatoes mashed in water; or an infusion of hay, with a small quantity of milk. The calf is allowed to drink as much of this as it likes between the meals which it takes from its mother: the remaining portion of the food which it has not consumed is given to the mother. The calf is thus gradually accustomed to this kind of food: it is allowed to suck only twice a day, and the cow is milked once. A quantity of very good hay is also given to the calf, which it soon learns to eat. Calves which are to be very carefully reared, are allowed to suck in this manner for five or six weeks.

When the calf is to be totally weaned, it is removed as far as possible from its mother, that they may not disturb one another by their cries—the manner in which they make known their ardent desire to be re-united—and that they may forget each other as soon as possible.

They must be well fed, that the calf may not lose too much in condition and the cow in milk; this loss is always experienced in some degree on account of the distress which the animals suffer. At the same time that the secretion of milk is favoured in this manner, the cow is brought to allow herself to be milked more readily, and not to retain her milk.

If the calf is intended to drink milk instead of sucking, it must not be allowed to touch the mother, but must be immediately removed from her. I do not agree with those who let the calf suck for the first two or three days, and afterwards accustom it to drink.

The calf learns to drink as easily as to suck; provided that, for the first two or three times, the finger wetted with milk be introduced into its mouth, and then its muzzle be thrust into the milk, it soon learns to drink by itself; and I am not aware of any case in which difficulties have been met with in this respect. The first portion of milk is given just as it comes from the cow, or diluted with a little warm water. For the first week, the mother's milk alone is given to the calf. Afterwards the milk is taken either warm and as it comes from the udders of the cows, or heated with a little boiling water. Some care must be taken in feeding calves in this manner. A proper medium must be observed with regard to quantity, so that the calves may neither take more nourishment than is proper for them, nor suffer from deficiency of food. Calves of different ages must, therefore, be kept separate, and the milk measured out to them accordingly. For the first week, 4 lbs. per day is sufficient: 8 lbs. should be given in the second; and 12 lbs. in the third: the quantity must, however, be gradually increased. The milk is always given to the calves in three separate portions. In the fourth week, the quantity of milk is not increased, but liquid food is added to it, of the same nature as that given to sucking calves. In the fifth week, skimmed milk not curdled is given to them; and they begin to eat a little hay, with potatoes, beet-root, &c. These substances, however, are given in small portions only; being put into the manger, chopped very finely. In the sixth week, the quantity of solid food is increased; and in the seventh, they are able to dispense with the milk and soup: if possible, however, a little skimmed milk is given to them, either sweet or curdled. From that time, I give them the same food as the cows, viz., raw potatoes and hay, while they are on winter food; and afterwards green-meat of all kinds. When they are ten or twelve weeks old, they are turned out to grass; excepting, however, the castrated calves, which are usually left in the stall.

I am aware that some persons object to green-meat and pasturage, apprehending that corpulence and weakness of the digestive organs may be thus produced, and accordingly they give their calves nothing but very fine hay and corn for the first nine months; but I have never known the slighest disadvantage to result from the use of green food: on the contrary, my calves have always continued very healthy upon it. There is, however, no objection to the method of feeding with dry fodder, provided the proper kinds can be obtained.

As to grain, I never give any to my calves, excepting when its price is very low, as was the case in the spring of 1811.

The reasons advanced for allowing calves to suck instead of giving them milk to drink, are not, in my opinion, valid. It is said—

(*a*) That it is natural for calves to suck, and unnatural for them to drink.

But our cows are not in a state of nature; neither is the end for which we keep them natural. Nature has given milk to cows solely for the nourishment of their calves; but our object is to leave as little as possible of this milk for the calves, because we wish to use it in another manner.

(*b*) That we cannot milk the cow so completely as the calf does by sucking.

A dairy-maid drains the last drop of milk from the udder of the cow and the four teats, better than the calf usually does. The calf either does not suck excepting when it is thirsty, and does not draw all the milk contained in the udder, or else it plays with the teat, and takes only a few mouthfuls now and then, leaving the thickest part of the milk behind. It often accustoms itself to certain teats only—to those on one side, for instance; and then the others lose their milk and dry up.

(*c*) That the practice of feeding calves by giving them milk to drink does not succeed in large cow-houses, because the method cannot be pursued with all the care and attention that it requires; and hence, that it can only be usefully applied when the number of animals is small.

This is contrary to experience. When calves are classified, and fed according to their ages, the most exact order can be observed in feeding them: when, on the contrary, they are taken to their mothers to suck, it is easy to pass one of them over. Moreover, the taking of them to their mothers occupies more time than giving them milk to drink. If, again, the calves are to suck at the time when the cows go out to grass, the mothers must be kept in the stall, and fed in a different manner from the rest.

Moreover, when calves drink milk instead of sucking, they remain quiet in the stall, and are not annoyed and distressed by being first taken to their mothers and then removed. Milk given to calves in measured portions, according to their ages, does them more good than they would receive by sucking sometimes a large and sometimes a small quantity. They are not exposed to indigestion from excess of nourishment; experience shows, indeed, that calves fed in this manner are less subject to diarrhœa than those which suck. The quantity of milk can also be proportioned to the strength and appetite of each calf; whereas, a calf brought up at the teat of its mother, is either unable to consume all her milk, or does not find a sufficient quantity.

The chief motive for preferring the method of making the calves drink is, that they become more easily and gradually accustomed not only to do without milk, but also to milk of inferior quality and to a different kind of food. Hence, when weaned, they do not fall off like calves which have been used to suck. The distress of the cow and calf, which they express by long-continued lowings, is also spared. The cow is accustomed to being milked; and as this operation gives her, from the first, an agreeable sensation, she willingly submits herself to the woman who milks her. Lastly, skimmed milk is more easily dispensed with, and thus a saving is effected.

The only case in which it may, *perhaps*, be better to let the calf suck, is when the cow is suckling her first calf; because by this means the lacteal vessels are more effectually opened.

When the method of giving milk to drink is adopted, the following mode of proceeding should be observed.

It is only for the first few days that the calf is fed with its mother's milk: afterwards it is sufficient to take care that the milk be taken from cows which have most recently calved: when the calves are three weeks old, they may be fed with any milk, provided it be good.

For the first week it is best to give the milk at its natural temperature; and if it has got cold, to warm it again with a little boiling water. Afterwards, the milk may be given at a lower temperature, or even quite cold.

In whatever manner the calves are fed, great care must be taken to prevent them from being seized with diarrhœa, and if they are attacked by this malady, to check it as quickly as possible. The remedy which I have found most efficacious is an extract of rhubarb, made with brandy. Half a pound of brandy is put upon an ounce of rhubarb, the mixture is exposed for four-and-twenty hours to a gentle heat, and frequently shaken. This tincture is then strained off, and a spoonful of it given twice a day to the sick calf. The malady generally ceases after the calf has swallowed a few spoonfuls; if not, five drops of tincture of opium may be added to each dose. We must then be more cautious in letting the calf drink, and not oblige it to do so until it has regained its appetite. Some persons speak highly of a broth made with lentils and acorns, roasted like coffee.

A calf which has had good nourishment during the first year of its life, may in the second be fed more sparingly, and on less abundant pasturage; provided, however, that the saving be not carried so far as to cause the animal to become lean and sickly.

During the third year's winter, it may be fed upon good chopped straw, mixed with a little hay. A young cow in calf for the first time must have better fodder, and both the quantity and quality of her food must be increased as she approaches the termination of her pregnancy.

Many persons do not consider it profitable to rear cattle; they estimate the expense of bringing up a cow at a higher rate than the purchase of good cattle. Many rural establishments, indeed, are not adapted for the rearing of young cattle; this is the case, for instance, where cows are taken in singly for a fixed sum. To me, however, it appears that the uniformity of breed which we obtain by rearing cattle ourselves is so valuable, that I should recommend the practice, even when it actually costs more than purchasing. But I do not think that this will be the case under ordinary circumstances, or unless there should be an opportunity of selling the milk fresh and at a high price.

When we know the annual return which a cow yields, we calculate as follows: for the first two years, a calf costs at most half as much as a cow; and in the third year, making even large allowance, the same sum as a cow; so that the whole expense is equal to that of two cows for a year: now it is rarely possible to purchase a young cow, without blemish, for less than this. The advantages of having cattle accustomed to a certain mode of treatment and a certain pasturage are well known, and they are greater in proportion to the inferiority of the pasturage.

If we do not intend to rear the calves, we must endeavour to get rid of them as soon as possible, that we may have the advantage of the milk.

The fattening of calves can be profitable in particular circumstances only—where good calves are bought at high prices for consumption in large towns, and where, also, notwithstanding the vicinity of these towns, there is no better way of disposing of the milk, either by selling it in its natural state, making it into butter and cheese, or using it in any other way.

Calves are fattened in two ways:

(*a*). On milk alone. This mode of feeding always produces the best and whitest meat, and is likewise more easy of application than any other. For calves which are to be fattened, the practice of suckling is attended with fewer inconveniences, because they are sold immediately after being weaned. But when a large number are fattened at once, they must be taken to their mothers or nurses at stated hours. It is necessary to accustom some of the cows to suckle calves which are not their own; some will do so without resistance. These cows may be used as nurses as long as their milk continues, and, if well fed, may thus be made to yield a larger return than otherwise; but they become quite unfit for milking. When fatted calves have attained the age of eight or twelve weeks, their mother's milk is often insufficient for fattening them completely: recourse is then had to other cows as nurses.

(*b*). By food of a different nature, given to them first in addition to their milk, and afterwards alone.

In this case, all sorts of mashes are provided for them, made from linseed, cakes of linseed, oatmeal gruel, boiled potatoes or turnips, and eggs; sometimes, also, with old white bread which has remained unsold at bakers' shops, and may be obtained at a low price. These mashes are given to the calves either alone or mixed with milk. In many parts of the country, and even in towns, there are persons who make a trade of fattening calves, and buy them very young for this purpose. To the farmer this mode of fattening calves is only of secondary importance.

The age of horned cattle cannot be determined by their teeth with the same accuracy as that of horses and sheep. Of the eight incisors of the lower jaw, which the calf brings with him into the world, or acquires very soon after, the two middle ones are usually shed between the twelfth and eighteenth month, and replaced by larger ones. After the second year, the two next teeth are changed in a similar manner, and so on every year. If the calves are very well fed, this change goes on rapidly; if not, it is retarded; and, generally speaking, the course of nature is less regular in horned cattle than in other animals, and consequently, in young animals of this class, the indications of the teeth are very deceptive.

It is a more general practice to look to the horns for indications of age; but the information which they furnish is likewise rather vague. In oxen, the lower ring, that which is nearest to the root of the horn, makes its appearance in the fifth year: in cows, this ring shows itself after they have borne their first calf; after that, a new ring is formed every year, and pushes the second forward. Young cattle do not shed their horns and acquire new ones, as is stated in a manual of the economy of live stock lately published. Some persons profess to have observed that cows do not acquire a distinct ring unless they have calved during the year; but that, in such a case, the space between the rings is proportionally larger. When they miscarry, we may expect the ring to be less distinct. I think I have observed this in some instances, but I do not regard it as an invariable rule. It is certain, however, that a regular disposition of the rings is a characteristic mark of a cow which has always been a good breeder, and that in one which has been sickly the rings vary both in strength and distance. In old animals the rings are not very distinct; indeed, they can scarcely be counted. The horns, which at first are strong at the root, and get gradually thinner towards the extremities, become, after the ninth or tenth year, thicker at top than at bottom. Other marks of more advanced age are, a deepening of the cavity above the eyes—also a deepening of the hind quarters, increased size of the hoofs, and the growth of white hair about the eyes. The latter may, however, be an individual peculiarity.

Feeding of Cattle.

The feeding of cattle is divided into summer and winter feeding. We shall first speak of winter feeding.

The winter food of cattle usually consists of dry fodder, hay and straw. The proportions in which these two kinds of fodder are given are very variable, depending on the means and circumstances of the rural establishment. Cattle are sometimes fed on straw alone during winter; but when reduced to this food, they not only become unprofitable, but likewise diminish to the last degree in flesh and strength. In some instances, this effect has not been observed to result from straw-feeding; but in such cases, the straw has been mixed with a large quantity of other kinds of grass, or some portion of grain has remained in the ear: it is well known, indeed, that in some rural establishments, the straw, especially that of oats, is for this purpose not wholly deprived of the grain which it contains. When no description of hay can be obtained for feeding the cows, it is usual to give them all kinds of refuse, independently of the husk of corn and the residue of the grain; and when they are near calving, a mash, composed of meal, bruised corn, oil-cakes, or other matters of a similar nature, are provided, to keep up their strength a little.

It is only the straw of plants which bear a great quantity of leaves, such as peas, vetches, haricots, lentils and buck-wheat, that contains a larger supply of nourishment. Its nutritive power is in proportion to the greenness of the crop when mown. Millet and maize straw, when properly prepared, likewise belong to the more nutritious class.

Among the ordinary corn-straw, that of wheat is undoubtedly the best adapted for fodder; next in value is the straw of oats and barley, which is also, generally speaking, more abundant in leaves; the least nourishing of all is that of full-grown rye.

But it is more common to give straw mixed with hay. The feed of cattle is usually considered good, when 1,000lbs. of hay can be allowed to each animal during winter, making about 6 lbs. per day; this quantity, however, is not distributed equally over the whole winter season, but saved, for the most part, till the time of calving; 8 or 10 lbs. per day is considered as good feed. It is certain, however, that an ordinary sized cow, which receives no other nourishing food, ought to have 12 lbs. of hay per day to keep her in perfect health; and 20 lbs. if she is also required to yield a good supply of milk. A large cow requires 20 lbs. per day; and if she gives milk, and we wish to keep up the supply, she ought to have 30 lbs. When only a small quantity of hay is given, it is mixed and cut up with straw.

For winter feeding, it is almost universally thought necessary to chop the straw. The chopped straw is divided into scheffels, one of which, coarsely divided for horned cattle, weighs about 9 lbs., taking the straw of spring and autumn corn together. For an ordinary native cow, from three-quarters to one scheffel per day is thought sufficient.

The cutting of straw requires considerable labour. With an ordinary machine, of the largest size, it is calculated that a man can chop 36 scheffels per day, but not very finely. Various machines have, however, been invented, by means of which a man can get through double or triple the quantity, without more trouble. Their mechanism is so contrived that the straw is pushed forward by cylinders, which, at each cut, present a certain length of it to the knife. The knives, or blades, are of the usual form, but larger; and as the workman can devote his whole time and strength to the raising and lowering of the knife, he can make twice as many cuts in the same time, and put more force into them. In this manner, provided that care has been taken to place the box a little higher than usual, each cut will furnish about a third more of chopped straw. Sometimes the blades are fixed to a wheel, the circumference of which is loaded in order to give it greater momentum; when its inertia has been once overcome, it merely requires to be kept moving to do all the work. Sometimes only one blade is attached to this wheel; sometimes there are two or three. A machine brought from England, which had three knives, and was well made, could not, on account of its great friction, be kept in action by one man; and when the knives were blunted, two men were not sufficient to move it. The one-bladed machine is generally preferred. *Karsten*, of Rostock, has given in the "Annalen des Ackerbaues," IIIer. Band. S. 507, the description of such a machine, made according to Lester's model, and with the improvements devised by himself. This machine is well executed at Rostock, by M. Haak, and at present, also, at Berlin, by Schulz, the mechanist, who sells it for 50 rix-dollars. In rural establishments of considerable magnitude large machines of this kind are also used; they are set in motion by draught cattle, or even by wind or water, and produce a large quantity of chopped straw in a short time. But all these machines, especially the more complicated, are liable to this defect, that something or other in them is apt to get deranged or broken, and in the country it is difficult to find a man capable of repairing the mischief. Accordingly, I have known cases in which persons, after laying aside the ordinary machines, have been thrown into great embarrassment by such accidents with the larger ones, and have in consequence become so disgusted with them, that they have put them on one side without making any further use of them. But it is to be hoped that the mechanical knowledge required for constructing or repairing a machine of this kind, will soon be generally diffused.

When cattle are sparingly fed, and straw is mixed with hay, for the purpose of making them eat as much as possible of the former, and thus making use of the small quantity of nutriment contained in it to deaden the sensation of hunger, the cutting of the straw is indispensable; but when they are well fed, I regard this operation as quite superfluous. The quantity of nutriment in the straw is not increased by it in the slightest degree: on the contrary, the cattle pick out the nutritive portions much better from straw which has not been cut. It is proper, therefore, always to give them the kind of straw which is used for litter. As to good hay, animals eat the whole of it, even though uncut. If the cattle are not hungry, they likewise pick out the best portion of the cut straw, and blow away the rest. We have then the trouble of removing from the manger a quantity of straw which has been cut at considerable expense.

Feeding with grain, whether used as a substitute for hay, or as supplementary to it, cannot be adopted on the large scale with any advantage, unless the price of milk be very high, or that of grain very low. It is certain, indeed, that a few pounds of grain per day considerably increase the quantity of milk; and when we have nothing else to give to the cattle, grain may be used with advantage for this purpose; but it is the dearest of all kinds of fodder. Moreover, milk and butter produced from grain alone are of bad quality, rather cheesy than rich, and have an unpleasant flavour.

Grain, when given to animals in its natural state, often passes through their bodies undigested: it is, therefore, usually ground; but this operation is attended with considerable loss, unless we have a mill of our own, moved either by hand or by water. This operation may, however, be dispensed with, if the grain, before it is given to the cattle, be soaked either in warm or cold water, or else prepared like malt. The development of the saccharine principle by the latter process considerably improves the grain, and renders the milk of better quality. The best kind of grain for milch cows is oats: great benefit is ascribed to a mixture of oats and tares, previously well ground. Barley is more likely than other kinds of grain to produce white, cheesy milk, and the butter produced from it is apt to acquire a bitter taste.

Siftings of grain, bran (whether of the large, middling, or small kind), mill-dust, and the residue of cleansed oats and barley, are most frequently used for feeding cattle.

All these kinds of grain-refuse should be mixed either with cut straw, or, what is better, in the mash. In winter, the latter method makes the cattle more inclined to drink.

We must here speak of the refuse of the brewery. This food has a very favourable influence on the milk: the proprietors of small cow-houses find it very profitable to buy the refuse of the brewers. As it can be obtained at a very cheap rate in summer from town brewers who do not keep their own cattle, we endeavour to keep it in trenches, which, when quite full, are closed with a covering, on which earth is thrown: the residue is thus preserved till winter.

The refuse of the brandy distillery cannot be better employed than for feeding cows; provided, however, that we have a ready sale for our dairy produce. It is either poured into the mangers on cut fodder, by means of pipes fixed for the purpose in stalls expressly adapted for it; or given in the form of mash mixed with water. The sooner it is used the better; for if it become acid even in the slightest degree, it will have a bad effect on the milk. It is best, therefore, to cool it with water as soon as it is taken out of the still. This kind of food must, however, be regarded only as an accessory, and given in moderate quantities; for when used to excess, it injures the health of the cows. The quantity given to a fatted ox must be divided between at least four cows. The residue of the brandy distillery also imparts a disagreeable flavour to milk.

A very attentive farmer used to complain that his calves became sickly, that their flesh stuck to their ribs, and they died. He thinks with me, that the evil arose from the mothers having eaten too much distillers' refuse.

Finally, oil cakes (the residue of the manufacture of oil), especially those made of linseed, have a very good effect. The best mode of proceeding is to put them into the mash; in which, however, they should be well mixed up. This is effected as follows:—A vertical division is made in the pail with boards, in which a number of small holes are pierced with an auger; the partition is so placed that the smaller space shall occupy a third of the whole. In this space the cake and water are placed, and frequently stirred. The liquid is then transferred to the other division, into which there cannot pass a single morsel of solid cake, but only the mashed portions. The oil-cake mixes gradually with the water which is added to it; care must therefore be taken to add a fresh portion from time to time. This renders the mash particularly agreeable to cattle, and evidently increases the secretion of the milk.

Bad linseed, crushed and boiled in water, forms a very nourishing drink for milch-cows. Spurry-seed is also used for this purpose; not however boiled, but merely swelled with warm water. It is recommended as one of the most substantial kinds of food for milch-cows.

One of the best kinds of food for horned cattle, and particularly for cows, and which completely supplies the place of a portion of hay during winter—consists of roots, such as potatoes, mangold wurzel, cabbage-turnips, transplanted turnips, rutabagas, common turnips, carrots, and parsnips. These roots must not, however, be valued at their market price, which is often determined by accident, but according to the outlay necessary for obtaining them by cultivation: it is rare indeed that these plants can be disposed of in the market in large quantities; and if by chance a high price towards spring-time should favour such a mode of disposing of part of them, the occurrence must be regarded as merely casual.

In the first volume of this work I have spoken of the nutritive power of these vegetables and their value as compared with that of hay; and of the average produce of them which may be expected from a well-cultivated soil: I have also spoken of it more at length in this volume, when describing the culture of each of these plants. Subsequent observations have convinced me that the proportional nutritive power there ascribed to them is determined with as much precision as we can at present attain. It remains therefore only to speak of the mode of using them.

These vegetables are used either raw or boiled. The boiling of potatoes is now performed by steam in almost all places where it is conducted on a large scale, because this method not only produces a saving of wood, but also ensures the proper degree of boiling. The best apparatus for this purpose is now well known, in consequence of the almost universal introduction of the distillation of brandy from potatoes. It consists of a brandy still of the usual form, which, like most of those of the recent manufacture, has no capital, but only a long neck, like that of a retort, from which the vapour is transferred through a tube into the vessel containing the potatoes. The latter is an upright cask, into whose lower part is fixed a false bottom, pierced with holes, to allow the escape of the water condensed in the vessel. The steam-pipes are introduced into this cask, care being taken to keep the lid well closed, and also the door, which is usually placed at the side. The water in the still is then made to boil, and the potatoes become cooked to the proper degree in a much shorter time than they would by being boiled in water.

It has not yet been decided by comparative experiments whether, or to what extent, root-crops, and especially potatoes, are improved for cattle by boiling. Experiments on a small scale seem, however, to show that the difference is not considerable, and does not compensate for the expense of the operation, how strongly soever this method may be recommended by theory and analogy. It is easily seen that cattle eat vegetables in the raw state with as much, and ultimately with more pleasure, than those which are boiled. It is only when potatoes are given in very large quantities, which is the case with fatted cattle, that boiling may be advantageous, by diminishing the laxative property which these vegetables certainly exhibit when eaten in considerable quantities. It is probably for this reason that many persons, particularly in England, who keep cattle in large numbers, recommend boiled potatoes for fatted oxen, and raw ones for milch cows. We shall hereafter speak of feeding on mashes or soups, and the use of root-crops for this purpose.

These vegetables should be cut in pieces, which is done on the small scale with a knife shaped like an S, made expressly for the purpose; and on the large scale by means of various cutting machines. Several machines have been invented for this purpose: the one best known consists of a strong solid wheel, armed with three blades, and composed of three triangular pieces of wood, joined together to prevent the passage of the roots. This wheel turns upon an axle in front of a box, in which the roots are placed, and cuts them as they are presented to it. The impetus with which the wheel moves facilitates the labour so much, that a weak person may perform it. The blades are straight, and cut the roots in the form of discs; or they have an undulating edge, and cut them into small elongated pieces. The latter effect has also been obtained by other cutting pieces placed across. In my opinion it is quite sufficient that the roots be cut into discs or flat slices; and this is even preferable, because small pieces easily adhere together, or become blackened, and ferment when left for some time in that state. Cattle certainly eat them more willingly when they are but coarsely divided: very minute division, indeed, cannot be of any use, excepting to prevent the animals from being swelled up. Curved edges are also more quickly blunted, and more difficult to sharpen.

I am still less disposed to admit the utility of those machines which reduce the roots, either raw or boiled, to a semifluid consistence: they are only useful for the distillation of brandy and other preparations made with these roots.

In constructing machines which mash the roots in this manner, the object in view is to mix them better with cut straw, so as to compel the cattle more effectually to eat the latter: but experience has quite altered my opinion on this point: in short, I have seen cattle which had been well fed, and had therefore become rather dainty, constantly endeavour to separate the cut straw from the pieces of root, and get rid of the latter by blowing upon them before they went on with their meal. I therefore have the roots given to them separately, and I find that they eat straw much more willingly when put before them whole, soon after they have eaten the roots, than that which is cut for the purpose of making them swallow it together with the roots.

A mixture of several kinds of roots, or the use of them one after the other, appears to me to be very advantageous. The several kinds of turnip, which contain a greater quantity of saccharine matter, are certainly an improvement to potatoes, which, on the other hand, are more farinaceous: the milk becomes sweeter in consequence, and acquires a better flavour; moreover the cattle like the change. But the preservation of turnips till spring is much more difficult than that of potatoes; and hence there is positive reason for having the turnips consumed first, the potatoes being reserved for use at a later part of the season.

However nourishing and advantageous these vegetables may be, we must not venture to use them long as the sole food of milch cows. A due proportion of dry fodder should always be added. It is true that the addition of a quantity of unmixed straw may be sufficient, and the cattle will eat it with avidity. But cows thrive best, and yield the greatest quantity of milk, when part of their food consists of hay. Other cultivators as well as myself have found that when cattle are partly fed on potatoes, it is best to give them half their feed in hay and half in roots, the quantity of the latter being regulated according to their nutritive powers. When, for instance, a cow fed solely on hay, would require 20lbs. of that substance, we may give her 10lbs. of hay, and make up the quantity with 20lbs. of potatoes, 46lbs. of mangold-wurzel,* 35lbs. of Swedish turnips, or 52lbs. of common turnips. When cows eat potatoes, the hay contributes greatly to improve their milk; for when they have nothing but potatoes and straw, the milk produces a white cheese-like butter, very apt to acquire a bitter taste, as is the case when cows are fed upon meal.†

When one kind of food is to be substituted for another, I have always found it important to make the change gradually. If, for example, cattle have been fed for a long time exclusively on beet-root, and, this kind of food being almost exhausted, we are about to substitute potatoes for it, it is proper, in order to prevent the cows from falling off in their milk, to feed them for a week on beet mixed with potatoes, the quantity of the latter being gradually increased; for although the cattle like the change, still they get so much attached to a particular kind of food to which they have been accustomed, that they do not abandon it suddenly without regret; the effect of the change is first seen in a diminution of the quantity of milk.

The method of giving food in the form of mash or soup has been very generally extolled, both from theoretical and practical considerations, as being well adapted to develop the nutritive principles. It is generally adopted in many countries, particularly in small rural establishments, where great attention is paid to the management of milch cows. Boiling water is poured, either alone or mixed with some nutritive substance, on the cut fodder; the mixture is then brewed and given to the cattle, after it has cooled a little. Roots, or some other farinaceous substance, like those already spoken of, may then be boiled in water, and more intimately mixed with the cut

* I should say 26 lbs.—French Trans.

† For the proportion in which potatoes should be given to cattle, see "Die v. Jenaische Versuche," A., in the "Neue Annalen," 3 er. bd. 1 stes. st. s. 102; "Die v Jenaische Versuche," A.

straw. I once tried this kind of food for two winters on twelve or fourteen milch cows, making up the total quantity required with roots and cabbages boiled in water, and obtained a quantity of milk much greater than I could have expected. The food was prepared twice a day, in two tubs, in the morning for the noon and evening meal, and in the evening for that of the following morning, otherwise the liquid would not be sufficiently cool. But though the vessels were frequently washed with lye, I could not prevent the occurrence of acidity during the slow cooling. This acidity, when slight, did no harm; but when it became stronger in consequence of high temperature, it made the food very unpleasant, so that none of the cattle, excepting those which were very hungry, would touch it. Moreover, I found, in the ensuing summer, that my cattle were weakened, and that their digestive powers were impaired; and I lost, during the time of feeding on green meat, more than I had gained during the winter. I therefore abandoned this mode of feeding, which was likewise very troublesome. I do not think that it can well be adopted in large establishments, or anywhere, indeed, excepting in small concerns where only three or four milch cows are kept, and the water can be warmed in pans; and farther, I think that it is fit only for cows from which we wish to obtain the greatest possible return for a time, and get rid of them afterwards.

The mixture already mentioned, of the refuse of the brandy distillery, while yet warm, with cut straw, may be considered as a kind of mash or soup.

In winter, cows should be induced to drink a great deal. They will not drink very cold water, unless compelled by excessive thirst, but tepid water they drink much more willingly. They may, however, be easily induced to drink by simply mixing a small quantity of farinaceous matter with the water; the oil-cake already spoken of is particularly well adapted for this purpose. Cattle should not be made to drink immediately after their meals, but in the intervals.

It is of great importance, in giving food and drink to cattle, to observe regularly the hours to which they are accustomed, and to give them at each time the kind of food which they are in the habit of receiving. At the beginning of the time of winter feeding, the arrangement may be made in almost any way; but when once fixed, it should be adhered to. In my establishment, the winter feeding has usually been arranged as follows: Early in the morning the cows are fed with cut straw and hay; at eight or nine o'clock they are watered; at eleven o'clock roots are given to them without any addition, then uncut straw; at three o'clock they are again watered, and after that, a little uncut hay is given to them. In the evening, they are again supplied with cut fodder, as in the morning, but in smaller quantity; and when they have consumed this, they get another supply of roots. A quantity of straw is then put before them for the night; they eat as much of it as they like, and the rest serves for litter on the morrow. In this part of the country I have never given salt to my horned cattle, because its high price would outweigh all the advantages which it might procure. At one time I used often to give it to them, and I found, beyond all doubt, that it increased the secretion of milk. When, however, it was used in excess, the cattle appeared to grow lean upon it, and the butter acquired a bitter taste.

The arrangement of our stalls makes good litter very advantageous to the cattle. The quantity should be regulated according to the supply of food, especially that of a succulent character. When cattle are ill fed, and on dry fodder only, three pounds of straw per day are sufficient; but when the supply of food is more abundant, ten pounds are scarcely sufficient to absorb the excrements and urine. In a season when straw is scarce, as was the case in 1811-12, if we should be compelled, in order to save a sufficiency of straw for summer stall-feeding, to reduce the quantity of litter at the same time that we give the cattle an abundant supply of roots, it will be necessary to remove the dung every day, in order to keep the cow-house dry and clean—unless, indeed, we can have recourse to other substances to supply the place of straw. A dry bed, even if it cannot be made soft, is indispensable to the health of cattle.

Many persons recommend the practice of currying cows. On fatted cattle, this treatment produces a surprising effect, but with cows I never observed any good to result from it that could at all compensate for the trouble it occasioned; the only care required is to keep the udder clean, and wash it before milking.

When a large quantity of litter is given to the cattle, at the same time that they are but poorly fed, the litter may be left under them for a long time. In the contrary case, the dung must be removed or drawn to the back of the stall at least twice a week. The dung is most easily removed by the drag; but the implement must be so formed as to allow of yoking both sides, so that it may not be necessary to turn it, but merely to yoke the horse on the opposite side.

Winter feeding may be calculated to last for seven months.* Pasturage usually continues till the middle of October, and is resumed in the middle of May (we shall hereafter speak of green feeding in winter). It is, however, prudent to reckon upon a fortnight longer, because if the spring be unfavourable, the grass feeding may be retarded for that time. Especial care is therefore taken to save the hay, because it can also be used in summer, or may be preserved till the following winter. A supply of hay or straw preserved from one year to another affords great security.

We have previously spoken of the various kinds of pasturage, and the extent required per head of cattle.

A pasturage, of which six acres are not sufficient for a cow of proportionate size, can scarcely be considered as

* On the borders of the lake of Geneva, the time is six months, from the 10th of Nov. till the 10th of May. Between the Alps and the Appennines, pasturage is sometimes to be had from the beginning of April; and in places where, as in Bologna, it is the practice to cut the heads of wheat, once, twice, or even three times, to prevent it from being laid, these heads are used to introduce the cattle to summer-feeding on green-meat.—French Trans.

cow-pasturage, or advantageously used as such. For, where a cow has to seek her food over a large extent of ground, she will not thrive, and her return will be reduced to a very small amount. These very poor pastures are only fit for sheep.

Experience shows that there are pastures particularly well adapted to favour the production of milk in cows, but on which cattle do not fatten; and others, on the contrary, which soon bring cattle into good condition, but do not produce much milk. I am not aware that the cause of this difference has yet been discovered. In many low countries, however, this fact has been so clearly established, that pastures are there divided into fattening and milk pastures, and each division is grazed by the kind of cattle properly belonging to it.

Every body knows that pastures, to be good for cows, must be free from acidity. Where the acid principle predominates, cows lose their milk, but oxen thrive well. I shall not pretend to decide whether this effect is owing to a transmission of acidity to grasses and other plants which are otherwise wholesome, or to particular plants which grow upon those lands. *Corn Horse-tail* (*Equisetum arvense*), and *Marsh Horse-tail* (*Equisetum palustre*) Colchicum, various species of *Ranunculi*, and other marsh-plants, are certainly injurious to horned cattle, and particularly unfavourable to the production of milk; but animals of this class do not touch these plants unless compelled by hunger.

Upland pastures, when rich enough to enable a cow to find full nourishment on three acres, produce a larger secretion of milk than lowland pastures, provided, however, that the race of cattle be adapted to them, for a large cow of the low countries would not easily find sufficient nourishment on three acres of upland pasture.

Outlying pastures lose much of their value from the distance which the cattle have to travel in going to them and returning: it is commonly said that the milk is lost on the road. The more quiet the cattle are on the pasture ground, the more profitable will they be found. It is for this reason that pasturages on the fields under the *alternate system of culture* is so valuable: on fields completely enclosed, where there is no occasion for either dog or herdsman, cattle enjoy perfect tranquillity, especially when left on them night and day.

Opinions are divided respecting the propriety of leaving cattle on the pastures during the night. Some persons think that it is most advantageous to take them back to the stall, not only for the sake of their health, but also to obtain a greater quantity of manure. But most cultivators who follow the *alternate system*, especially those who make it their business to keep cows, are positively of opinion that the cows should be left on the pastures for the night-time, during the warmest months of summer, as otherwise their milk is considerably diminished. The assertions of some parties respecting the hurtful influence of dew and fog, and the injurious quality of grass still wet with dew, are altogether without foundation, at least with regard to high grounds enjoying a salubrious atmosphere. It is only in damp situations, in the midst of marshes, that fog can be hurtful. In the cold nights of spring and autumn, however, the cattle should always be taken back to the stall: and if in the morning, before they are sent to the pasturage, a little dry fodder, though it be merely good straw, can be given to them, they will be much benefited by it.

With regard to other kinds of pastures, it is rarely advantageous to leave cattle on them for the night, if it be only because the dung is lost upon them. On the enclosed fields of the *alternate system*, on the contrary, the dung is of some use to the land, especially if the cattle are all collected for the night on the field which is first to be brought into cultivation.

When cattle are tended by a herdsman, the manner in which they are treated is by no means indifferent. The herdsman should, as far as possible, leave the cattle to themselves, or, at all events, guide or drive them before him with gentleness, and never allow the dog to hunt them. As the cattle advance in grazing, the herdsman should guide them in such a manner that they may always walk before the wind, and never have it in their faces. But it is of especial importance that the cattle be not disturbed when they lie down to ruminate: they then require absolute repose.

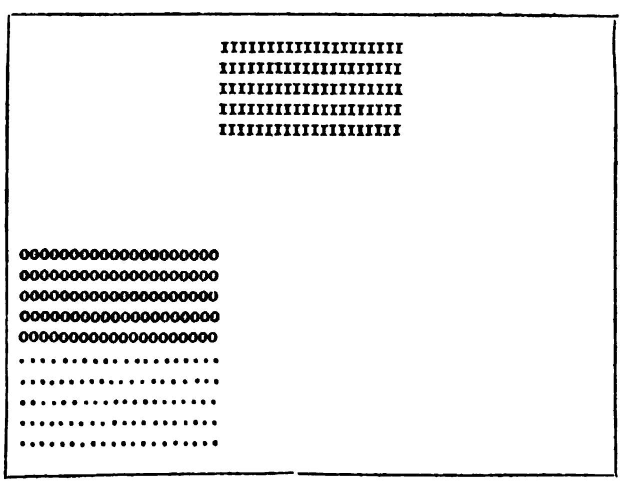
The question as to whether a cow gives more milk at pasturage or when stall-fed, may perhaps be decided in favour of the former, supposing that she is in both cases equally well supplied with food, and tended with the same care. Indeed, I am not acquainted with a single instance in which the total product of milk from a whole herd has been so high on the average during stall-feeding, as when the cows are fed on the best pasturage. This latter case, however, is but seldom realized.

The method of tethering cattle on the pasture, called by the Germans *tüdern*, or *töddern*, holds the middle place between pasturage and stall-feeding. This method consists in fastening the animal by a cord, having a swivel adapted to it at the end which goes round the neck, and is fixed to a stake at the other end, where there is often a second swivel. As applied to separate animals, this method is pretty generally known: but, as far as I am aware, its application to herds of more than a hundred cattle, is confined to Denmark: for this reason I think it right to transcribe, in this place, the description of the method which has been communicated to me.

In applying this method on the large scale, it is necessary to keep the animals as close together as possible; first, that every part of the ground may be turned to account; secondly, that the dairy-maids may not have too far to go in carrying the milk to the cart, which is to take it away, and is placed for that purpose in the centre of the herd; and thirdly, that the dung of the cattle may be equally distributed. The cows are usually collected in divisions of twenty, because that is the number which a dairy-maid can milk. In commencing the pasturage of a field according to this method, the cows are placed in a row, the last being fastened at the extremity of the field. The distance between one cow and the next depends upon the length of the cord, and that again is determined by the quality of the pasturage. At Thorserg, where second-year clovers are consumed in this manner, the cords are 10 feet long, Rhine measure. The stakes are so placed that the cows can approach close together, without, however, touching one another; and thus all parts of the surface are reached by their teeth. When the first division has been cropped, the second is arranged at a distance, varying from 60 to 80 feet, according as the soil is good or bad; the third and fourth divisions are arranged in the same manner.

The spaces left between the preceding are next grazed; for which purpose the stakes are removed, and planted forwards, after the space determined by the length of the cord has been grazed; and this succession is continued till the first division has come into the position previously occupied by the second; the second into that of the third, &c.

The following figure will give an idea of the mode of proceeding:—



Let the enclosed space represent a field of pasture-ground, and the dotted lines five divisions of twenty cows each. The cows graze the portion assigned to them until it is completely exhausted. The whole herd is then moved forwards to the spaces marked oooooooooooooooooooo. When the herd has in this manner reached the extremity of the field, they come back in the same order as shown by the marks, IIIIIIIIIIIIIIIIII, and so on till the whole field is depastured.

As the whole herd must not only be frequently moved, but also led to the watering place, it is essential that a man be able to lead twenty cows and more at once. For this purpose the cows must be fastened together, which is done as follows: The herdsman begins at the right wing of the first division, attaching the cord to the first cow in such a manner, that he can suspend it from the horns of the second. He proceeds in the same manner with the cord of the second cow, which he attaches to the horns of the third, and thus he links together twenty cows in one line. The cowherd walks on the left wing, and leads the animals to water; they drink without being unfastened. On returning, he fixes in the ground the stake of the cow which he has been leading on the left wing; he then takes the cord of the second cow which was attached to the horns of the third, and fixes it in like manner, proceeding in the same way with the third, fourth, &c. In linking them together, he always begins on the right; in separating and fastening them to the stake, on the left.

If, as is usually the case with fields of this description, the watering place be near at hand, the herdsman takes only one division at a time. But if it be distant, or if the cattle are to be led to another field at some distance from that in which they have been grazing, several files are united together. This is easily done by attaching the cord of the cow on the left side of the second row, to the horns of the one at the left of the first row, &c. But when the cows are to be watered, the several divisions must be again disunited.

The facility of this method of linking and separating depends partly on the animals being accustomed to it, but more on the skill of the herdsman. Sometimes one man is required for twenty cows; at other times, one cowherd can without difficulty take care of fifty.

The cattle become so readily accustomed to the method, that after a time they place themselves in rows and divisions, almost of their own accord; and thus the care and circumspection required become much less burthensome than when the cattle are stall-fed. The method under consideration resembles stall-feeding, however, in this respect, that the cattle injure but very little of the fodder with their feet, and may be made to consume the crop in the most favourable stage of its growth, after which vegetation soon recommences; hence the quantity of land required for supporting an animal is not greater than that which would be necessary in stall-feeding.

A comparative experiment, made at Thorserg, on the relative advantages of *grazing with the tether* and stall-feeding, gives the following results:—

Four cows, stall-fed, during twelve days, gave 1,110 lbs. of milk; extent of land required, 2,172 square fathoms; quantity consumed, 6,144 lbs. clover: which gives for one cow in a day, $23\frac{1}{8}$ lbs. of milk, $45\frac{1}{4}$ square fathoms, 128 lbs. clover.

Four cows pastured by the tether for twelve days, gave $950\frac{2}{5}$ lbs. of milk; extent of land grazed, 1,842 square fathoms: which gives for one cow in a day, $194\frac{4}{5}$ lbs. milk, $38\frac{3}{8}$ square fathoms.

Therefore the stall-feeding consumed the produce of 330 square fathoms more than the *pasturage by tether*: on the other hand, the quantity of milk was greater by $159\frac{3}{5}$lbs. in the former case than in the latter.

For 1lb. of milk the stall-feeding required $1\frac{581}{555}$ square fathoms: the *pasturage by tether* $1\frac{1117}{1188}$ square fathoms of clover-land.

Therefore, according to the same result, the 330 square fathoms which remained untouched in the *pasturage by tether* of a given number of cows would, if consumed in the same manner, have yielded $170\frac{1}{5}$lbs. of milk, which, with the $950\frac{2}{5}$lbs. actually produced by the four cows fed in that manner, gives a total of 1,120$\frac{3}{8}$lbs. of milk: as much, therefore (and even 10$\frac{3}{8}$lbs. more) than the same number of cows yielded when stall-fed on the produce of the same extent of clover-land.

According to this experiment the same quantity of milk is obtained from a given quantity of clover ready for the scythe, and the same number of cattle may be fed upon it, whether they are *pastured by the tether* or stall-fed. Hence there is no peculiar advantage on either side.

It must be remembered, however, that when cattle are stall-fed, the quantity of dung obtained is two-thirds greater; for when they are *tethered* there is not more than one-third of the dung profitably applied to the land. On the other hand, the stall-feeding must be charged with the additional expense of mowing and carrying the clover.

It will probably be disadvantageous to have the same clover-field grazed twice by cattle thus tethered, because the excrements which they leave on the ground during the first grazing may disgust them with the second shoot. It is better, therefore, to make the second crop into dry fodder.

In the first volume of this work I have spoken of the advantages which stall-feeding confers on rural economy in general, and in this present volume I have described the cultivation of plants intended for feeding cattle. It only remains, therefore, to speak of the mode of giving this food and tending the cattle.

A stall properly arranged for feeding greatly facilitates the work to be done; and of all arrangements which can be made, that which I have recommended in the "Introduction to Bergent's Economy of Live Stock" appears to me to be the most convenient, because it enables us to spread the fodder well, and give it to the cattle in small portions and in the most convenient manner.

Some persons, thinking it better to feed their cattle in the open air, have inclosed a yard with hedges, furnished it with mangers and racks, and put their cattle in it, leaving them at liberty to walk about as they pleased. This treatment has been adopted from the notion that free air and exercise would be more favourable to the cattle than constant rest in the stall. In the long run, however, experience has not been in favour of this method, but has shown it to be attended with the following inconveniences:—The cattle eat the fodder too greedily, but against each other; and the weaker animals are completely driven from their food by the others. The dung is also deteriorated in quality. From theoretical considerations, we might perhaps be apprehensive lest the close air and confinement of the stall should be injurious to the cattle; but experience shows us very clearly that this is not the case, and that stall-fed cattle, when well treated, always continue healthy, yield abundance of milk, and live to an advanced age: this has been the case even when they have never quitted the stall. But it is undoubtedly better to let them go out twice a day for the sake of removing the dung, watering them, and, if necessary, letting them bathe.

The places for the cattle should be so disposed as to leave the animals a proper quantity of room in proportion to their size, and particularly to allow of sufficient depth for removing the dung from under them, and heaping it up against the wall, and at the same time leaving a free passage behind them. It is also necessary that there be a gutter behind the cattle, by which the large quantity of urine produced by a plentiful supply of green-meat may drain off, or be removed and swept away. The supply of liquid manure increases or diminishes according to the quantity of litter put under the cattle; but it is rarely possible to put a sufficient quantity for absorbing the whole of the urine; for that purpose 15lbs. of straw, and even more, would be required for each head of cattle.

When the stalls are well built, boarded, and furnished with proper drains, and care is taken to keep the places occupied by the cattle clean with the broom, the litter may be dispensed with. This is proved by the experience of cultivators in the Netherlands, on the banks of the Rhine, and in Switzerland, and even among ourselves by several farming establishments which have been introduced by persons from those countries. This is the best mode of keeping the cattle clean; but where there is no scarcity of straw, the use of litter is preferable, inasmuch as it increases the quantity of manure.*

The stall should be furnished with windows for the admission of light and air, and capable of being opened or shut at pleasure.

Clover is usually regarded as the only proper subsistence for summer stall-feeding, but this opinion is altogether unfounded. This is not, and cannot, be the case, unless the stall-feeding is to be continued for a few months only, instead of being used as a constancy. Cows were stall-fed in summer before clover was known. It is certain, however, that when clover is in season, it furnishes the best and cheapest fodder that can be had. But green-feeding commences before clover is ready for mowing: and this kind of fodder fails, not only between the first and second crop, but also towards the end of summer. It is therefore necessary to procure other kinds of green food to precede the clover, and fill up the voids which that plant would leave in the course of summer-feeding.

The plant best suited for the first kind of green food is autumn-colza, sown towards the end of the preceding

* I think that the science of rural economy has yet much to learn upon this point. It is clear that the straw adds little of itself to the quantity of nutriment contained in the manure, increasing its bulk rather than its intrinsic value; above all, we must remember that the real value added to the manure is not equal to the cost of the straw in its natural state. On the other hand, the straw used in feeding cattle, though not very substantial, nevertheless contributes something towards their nourishment, and it is, undoubtedly, more animalised by passing through the bodies of the animals, and therefore better adapted for manure, than when simply mixed with the dung of the cattle, without passing through their bodies. It appears to me, then, that by using straw to feed cattle, of a particular kind, we may gain a great deal both in the use of the straw and in the quality of the manure produced from it. This, however, cannot be done with milch-cows; for, by making one quarter of their nourishment consist of straw, the quantity of milk would be reduced by about two-thirds. Neither can this kind of food be given to young animals; for it would retard their growth. It can, therefore, only be given to the working cattle during the time when they are but little employed.—FRENCH TRANS.

year. Next comes rye, which has been sown for the purpose. Both these articles are sown on part of the field intended for root-crops, or perhaps for late vetches, so that it will be necessary to break up the soil as soon as they are gathered. The sowing of these plants costs nothing beyond the seed and the labour of spreading and covering it. When wheat sown in autumn is particularly strong, the heads may be cut off, and used to aid in feeding the cattle. By this time the lucerne is ready for mowing: it is always the main prop of the stall-feeding. Then the clover begins to put forth its flowers, and reaches the stage in which it may be most advantageously given to the cattle. When the first crop begins to get too hard, recourse is to be had to tares and various mixtures of this plant, with others which cannot be dispensed with, unless we have a field of lucerne of considerable extent to serve as a supplement to the summer feeding. At this time also spurrey may be brought into use. Then the second crop of clover is ready for mowing; and if perchance it should not be very abundant, or we wish to make it into hay, in order to plough up the stubble sooner, we must then resort to a mixture of tares sown later than the rest—buck-wheat, early sown colza, spurrey, and the third crop of lucerne.* Then, with perhaps a third of clover, a fourth of lucerne, assisted by the annual fodder plants just spoken of, the end of September is reached, at which time the cattle may be abundantly supplied with cabbage-leaves, mangold-wurzel, turnips of various kinds, and even the haulm of potatoes; and thus without any other assistance, beyond perhaps a little hay or straw, we reach the end of October.

Stall-feeding, on green meat, may thus be continued for six entire months, that is to say, as long as, or even longer than pasturage. But it is often thought desirable to let the cattle go out during part of the day; when, for instance, advantage can be taken of a nutritious stubble

* Or rather the fourth in places where this plant grows luxuriantly.—French Trans.

on the corn-fields, particularly on those which bear clover sometimes, or of which clover has been twice mown, and is intended to stand. In this case, it is sufficient to give the cattle a small quantity of light food before sending them to the field, and thus they are treated by the system commonly called *half-stall-feeding.*

The method of *half-stall-feeding*, united with pasturage during part of the day, has gained many advocates, and is particularly well adapted to the circumstances of certain rural establishments, where, for instance, there is a pasture which, from liability to inundation, or some other cause, cannot be used in any other way, and is, at the same time, insufficient for the full nourishment of the required number of cattle. For this reason, the system of *half-stall-feeding* is established with great success in several rural establishments on the banks of the Elbe, Weser, and other rivers, not kept in by dykes, or enclosing within their dykes lands which are fertile but exposed to inundation, and therefore not adapted to the ordinary system of cultivation. It is certain that this variety of diet stimulates the appetite of the cattle, and causes them to eat more and yield a larger quantity of milk, provided always that the pasturage be of good quality, for if bad, it will only serve to dissipate the milk produced by stall-feeding. Positive injury, therefore, often results from turning cows out of the stall merely for the sake of turning a bad pasture to account.

It is only in very small rural establishments that green meat should be carried by servants in fodder-baskets. This practice is, however, sometimes adopted in establishments containing from twenty to thirty head of cattle. I consider it quite inconsistent with a good system of management, whatever may be the circumstances of the establishment. Sometimes, the carriage is performed by the plough horses; they take the fodder-waggon to the field when they go to work in the morning, and bring it home loaded when they return at noon or in the evening. This plan seems to me to occasion much disorder and loss of time.

The labour may be very well executed by the cows, if they are put to it in turns; some of them may be readily accustomed to it. This light work, far from injuring their health, or diminishing the quantity of their milk, is always found to agree with them perfectly well. One or two oxen intended for sale in the autumn may also be devoted to this work. It is true that they will eat a great deal, both on arriving at the field and on returning home, but they will fatten sufficiently to repay the value of the fodder which they have consumed.

Oxen daily employed in this work soon become so much accustomed to it, that they will go alone with the waggon to the field, and bring it back again alone when loaded.

When the labour of mowing and gathering the green crop is well regulated, the number of persons engaged in supplying food for a herd of forty oxen is not greater than would be required to take care of the same number while grazing; for a man who would be occupied in taking care of the cows out at grass, may very well mow and bring in the necessary quantity of fodder. The dairy-maids assist in distributing the fodder, and this light labour is amply repaid by the saving of the distance which they would have to walk in going to the pasturage, and of the additional trouble of milking in the open field. The trouble of clearing the dung out of the stalls may very well be laid to the account of the larger quantity of manure obtained.

Many persons consider it absolutely necessary to cut the clover, an operation which occasions great increase of labour. I consider it altogether superfluous, excepting during the first week of the transition from dry to green fodder, a time at which the latter is not abundant but very active. The object of this method is to save fodder, but if this end is actually attained, the quantity of milk is at the same time diminished. It is thought also that the same method prevents the loss occasioned by the cattle throwing their long green food about in the stall as they do in the fly season, but the quantity lost in this manner is quite insignificant, and, in my opinion, far exceeded by that which the cattle leave in the mangers when the clover is too finely divided. Cut green meat soon becomes heated and completely spoiled. The *hove*, or *blown*, which is so much dreaded from feeding on long clover, is not at all likely to occur if the cattle are regularly fed, and never allowed to suffer from hunger and afterwards eat to excess. For twenty-six years, during which my cattle have been stall-fed, I have never lost an animal fed on clover by this accident. It is true that long clover sometimes has a laxative effect on cattle, and that this inconvenience is obviated when the clover is cut up with straw. But this evil may be just as well prevented, or, at all events, diminished, by giving the cattle a quantity of uncut straw, which they will eat with avidity when their bowels are relaxed by the use of succulent green food. In that case, it is also very useful to give the animals a little dried hay in the morning.

It is of great importance to distribute the fodder in such a manner that the cattle may not eat it too fast, which they will be sure to do if the quantity of food intended for a meal be given to them all at once. Each meal, of the three usually given in the course of the day, should be subdivided into three portions, to be eaten at intervals of an hour: for example, in the morning, at five, six, and seven o'clock; in the middle of the day, at twelve, one, and two o'clock; and in the evening, at seven, eight, and nine o'clock.

The cattle must be watered in the intervals between their meals, and not immediately after they have eaten: in the forenoon at eleven o'clock, and in the evening about six o'clock. Good pond water is usually preferred by cattle to river or spring water.

In places where it is possible, we must not neglect to have a ford or bathing-place, and send the cattle to it twice a day. There is nothing more refreshing to cattle in summer, or more conducive to their health and cleanliness.

In the arrangement of cultivation, matters must be so disposed as always to ensure a sufficiency, or even a superabundance of clover or other green food for the cattle, so that if one sort should fail, we may have recourse to another. As soon as we perceive that the quantity is greater than we require, and that the fodder may become too much hardened, we must make it into hay and pass to another kind of food.

It is impossible to indicate, even approximately, the extent of each kind of fodder-plants required for supporting an animal, for the produce of a field is so variable, that in one year it may be double of what it was in the preceding. On good barley land, an acre of fodder plants will generally be sufficient for one large animal. I have even known cases in which 100 perches, or 144 square feet, have been sufficient. But prudence forbids us to reckon upon less than an acre and a half even of good land, favourable to the growth of fodder-plants, and two acres of a less favourable soil. It will not often happen that the whole produce of this extent of ground will be used, but no loss will result from this circumstance. If we have contrived to save a supply of hay from the preceding year, which may easily be done when the clover has been successful, there will be no occasion for reckoning on so great an extent of ground for a head of cattle, and consequently a greater number may be maintained; for such a provision is always an available resource.

Alternate feeding on dry and green fodder is always agreeable and beneficial to cattle.

Some cultivators have fed their cattle for the whole summer on dry fodder, chiefly on clover, and speak very highly of the method. But, in the first place, it is very difficult to provide a supply of hay which shall suffice till a fresh crop can be given to the cattle (which should never be done till the latter is thoroughly dry); and secondly, the hay-making is attended with much greater outlay and risk than consumption in the green state. The method in question also appears to me to be attended with great difficulties on account of the magnitude which must be given to the sheds for preserving so large a quantity of hay; in fact, it is necessary first to consume the whole of the last year's produce. Lastly, it is very probable that as the fodder dries, not only the watery portions, but also a great many useful principles are separated from it by evaporation, and that several substances contained in it enter into new combinations. We are not in possession of any comparative experiments on this subject of the degree of accuracy which would be desirable, but only of a few scattered observations; these, however, point to the conclusion that a given quantity of fodder, when consumed as green-meat, is more advantageous, particularly to cows, than when dried.* The nourishment contained in the fresh juice of plants apparently passes more easily into the blood, and becomes more readily available for nourishment, than when redissolved in a foreign liquid.

Milk and butter produced by dry fodder never have so good a flavour as from feeding on green-meat. It is also remarkable that all animals prefer green to dry food, though they willingly eat the latter for a change. The stall-feeding of oxen on hay may, however, be attended with some advantages.†

* It is evident that fodder-plants in drying, lose a great part of their leaves, flowers, and, in general, all their most delicate and substantial parts, which either remain on the ground or are lost on the road; whereas, if the same fodder be gathered and consumed as green-meat, the loss is quite inconsiderable. I have made, and likewise induced my friends to make, certain comparative experiments for determining the advantage of consuming fodder in the green, rather than in the dry state, and have always found a difference of ¼ in favour of the former; that is to say, that if 100 lbs. of green clover were sufficient to keep a cow, 125 lbs. of the same clover would be required for that purpose in the dry state. These experiments have never been made with the accuracy which I look for in an experiment whose results are to be considered decisive: but they have been sufficiently multiplied in various places, and by various persons, to give their results a high degree of probability.—French Trans.

† Long experience has convinced me that green feeding is well suited to beasts of labour, both horses and oxen, and that the animals, when accustomed to such food, keep up their strength on it much better than on dry fodder. In general, my oxen get very fat upon this kind of food, as soon as the spring-work is over, and they are put to lighter work; and during the laborious interval from harvest-time to the end of October, when they have no rest, excepting on fête-days, and during very heavy rain, the animals sustain their labour with perfect vigour, and preserve their condition; whereas, when I was in the habit of feeding my oxen on dry fodder, they used to enter upon the winter in a very lean and jaded condition.

When my working horses are fed on green meat, I never give them corn, excepting at the time of their severest labour, and they nevertheless perform their work cheerfully and well.—1815. French Trans.

In order to recommend dry-feeding in summer, the most unfounded apprehensions have been suggested against feeding on green-meat. Thus, it is recommended never to gather the fodder while wet, especially with dew. But, according to my experience, this practice is by no means objectionable, provided only that the fodder be left on the ground till it begins to get hot, without being cocked. It is necessary either to deposit the supply of fodder in a place large enough to admit of its being spread out in a very thin layer, or else only to bring enough for one meal at a time. In wet weather the fodder will not be injured, even though left for some days in breadths upon the ground.

I have never known cattle to be injured by young clover mown before flowering, when it was given to them in moderation. But if it be given to them in very large quantities at a time when they are very eager for green-meat, or if they are allowed access to the place in which it is kept, it may undoubtedly produce indigestion, and its consequence, the *hove* or *blown*. Besides, it is not economical to mow the clover which has put forth its flowers, because in the week during which the flowers come out, the plant increases in volume more than it has done for the five weeks preceding. If a field of clover be mown once a fortnight during six weeks, and each crop yields 30lbs. of fodder, making 90lbs. in the whole, the same extent of ground will yield 600lbs. if the crop be mown only once during the six weeks: this has been positively demonstrated by a comparative experiment expressly directed to this subject.

This is one of the main causes which render the produce of a given extent of surface so much greater when the crop is mown than when it is fed off, the plants not being allowed in the latter case to attain their full development. The question as to whether a cow yields a greater quantity of milk when pastured or stall-fed, leaving out of consideration the greater or less extent of ground employed in feeding her, can never be decided in a general manner. The same cow which on pasturage of good quality, but not extraordinary richness, will yield ten quarts of milk per day, may, when stall-fed, yield no more than six quarts, or as much as fourteen quarts, accordingly as her feed is scanty, or substantial and abundant. If, however, the pasturage be of the richest and most abundant description, so that the cattle are not able to consume the whole of it, I believe that a cow will produce more milk upon it than upon the most abundant supply of green food that can be given to her in the stall. Trustworthy persons assure us, that certain cows fed upon the best and most milk producing pastures of the low countries, have given from 90lbs. to 100lbs. of milk per day at the time of their greatest abundance: and I am not acquainted with any positive instance of stall-fed cows having yielded more than 60lbs. in the same time.*

There is too much difference between races and individuals, too much irregularity in feeding and maintenance, too much variety in the mode of treating and making use of the products of the cow-house, as well as in their price, to enable us to form any general estimate of the produce, and still less of the pecuniary return of a milch cow. There are positive examples of cows having, under active management, and in the neighbourhood of large populous towns, yielded an annual return of 200 rix-dollars, and others in which the whole produce in milk of a cow has not amounted to three rix-dollars. Undoubtedly there are cases in which the produce of a cow far surpasses the value of the fodder which she has consumed, even if we estimate it at the market price; but this seldom happens under ordinary circumstances. The calculation, however, assumes a different aspect if the fodder be valued, not at the market price, but at what it cost when raised upon the land; and it is in this manner that the valuation must in most cases be conducted; since it is impossible to turn fodder

* I know of instances, rare it is true, in which 90 lbs. of milk have been obtained from stall-fed cows; in addition, however, to the green meat, bran was put into their broth. Moreover, these cows were remarkable animals, of large size, and excellent breeds; altogether a kind of prodigy.—FRENCH TRANS

to account in the market. Circumstances are so varied in this respect, that we can add nothing to what we have already said on the subject. The gross profit of a cow, without deducting fodder, pasturage, and attendance, or reckoning the value of her dung, varies (if we except cows fed with excessive parsimony, and those most abundantly nourished) between 10 and 30 rix-dollars. The average profit of a cow, in well-managed rural establishments, may be set (taking the average of 40 weeks, or 280 days, during which they are milked at four quarts per day) at 1,120 quarts in all. Now 12 Berlin quarts yield on the average 1 lb. of butter; therefore a cow will yield 93⅓ lbs. of butter per annum.

	rd.	gr.	p.
A pound of butter, selling for six groschen, this amounts to	23	8	0
Cheese and the refuse, reckoned at two groschen for 12 quarts	7	18	8
	31	2	8

Seven rix-dollars, eight groschen, eight pence, constitute about the whole expense of attendance, cleaning and the dairy, which a cow-keeper will have to pay. Hence 24 rix-dollars is the highest price that should be given for the produce of each cow; but this price would leave no profit, and is therefore realised only now and then in seasons when the price of butter rises very high. But in rural establishments distinguished for the good management of their cows and the goodness of their pastures, the net profit of a cow, even after deducting all expenses of attendance, cleaning, and other accessories, may perhaps be raised to 35 rix-dollars; supposing, however, as already observed, that butter is at a high price.

It has been said that when cows are better fed they yield a larger produce, but that the increase does not counterbalance the additional expense; that, for example, it is not profitable to buy hay for cows. But this depends upon locality; the market price is much higher than that for which I can generally procure hay or fodder to supply its place. When the growth of a scheffel of potatoes costs me at the most two groschen, and a quarter of a scheffel given daily to a cow, increases the daily value of her milk by one groschen, I gain two groschen per scheffel by this mode of proceeding. The quantity of food necessary for preserving the life of a cow ought to be given to her under all circumstances, and independently of all considerations of profit; it is the surplus only that produces milk or increases the flesh; and consequently it is only from this surplus that any profit can be obtained. Hence it follows that the profit resulting from fodder is greater in proportion to the quantity consumed, provided always that this quantity be not greater than the digestive powers are able to convert into blood and other animal matter. We may also conclude from the preceding observations that it is not advantageous to maintain three cows on the fodder which two are able to consume and digest; this, however, is often done, and will continue to be practised as long as cultivators persevere in reckoning the profit of their cow-house at so much per head of cattle.

The quantity and quality of nourishment best adapted for a milch cow cannot be determined by general rules, but must be varied according to age, breed, and individual peculiarities. For a full-grown cow of average size, the most appropriate quantity appears to be either 18lbs. of hay, half of which may be replaced by roots, or 80 lbs. of green clover. As to large cows they may advantageously consume from 25lbs. to 30lbs. of dried hay, or from 112lbs. to 140lbs. of green-meat. Besides this, as much straw may be given to them as they will eat.

Cows are most abundant in milk at the age of six or seven years; and, if they have not calved before their third year, may be maintained in the same state till the twelfth. I do not think it economical to get rid of a cow which is free from defects merely because she is ten years old.

THE DAIRY.

The produce of the dairy is, in this country, the most usual mode of turning horned cattle to account. Fattening is generally regarded as an accessory. We shall speak first of the dairy, and afterwards of the fattening of cattle.

Milk may be disposed of in three ways; first, by selling it as it comes from the cow; secondly, by converting it into butter; thirdly, by making it into cheese.

The desire to get rid of the trouble of inspecting the dairy and cow-stalls, and to ensure a certain and immediate, though smaller profit, has in many countries induced the majority of great farmers to let their dairies. On almost all the estates in Mecklenburg and on many in the Marches, there were formerly cattle-farmers who were there called *Hollanders*, just as dairies in these countries are called *Hollanderies*. The farming was usually arranged according to heads of cattle, and consequently endeavours were solely directed to increase their number, even though pasturage and fodder were continually diminished by the practice; this is perhaps the chief cause of the bad state of cattle in those countries. The cultivator ceased to take interest in his milch cows, and *there is nothing like the master's eye for fattening cattle*. The interest of the rural establishment became divided between two branches of economy, the cultivation of produce and the management of cattle, which can never thrive unless they go hand in hand. Unless the farmed herd were very numerous, consisting of 100 head of cattle or more, the advantages which it was necessary to concede to the farmers swallowed up the greater part of the rent.

To save the trouble of inspecting, not only the cows, but likewise the operations of the dairy and the preparation of cheese, which can never well be executed except by careful women, it is much better to sell the milk just as it comes from the cow at a reasonable price to a dairy-man. In this way both parties feel a certain security, and take interest in the milch cows and their produce: innumerable difficulties are avoided, and the contractors no longer seek to take advantage of each other, as they always do with regard to quantity of fodder when the farming is arranged according to the number of cattle. I look upon all other modes of farming as inconsistent with a good system of economy.

Great care must be taken that the cows be completely and properly milked, for a scanty produce of the dairy often arises from neglect of this matter. It requires the constant attention of a woman capable of teaching the dairy-maids how to go to work. She must, upon the least possible suspicion that a cow has not been well milked, put her own hand to the udder, in order to attest the reality of her doubts, and draw off any milk that may be left in the udder. This attention is required, not for the sake of any additional quantity of milk which may be obtained at the time, but to prevent the loss which would result from diminished lacteal secretion, and to check the progress which carelessness is sure to make, when not promptly corrected.

The four teats must be milked one after the other, even if one of them should not give any milk.

If the udder be foul, it must be washed before milking, because the slightest foulness gives a bad taste to the milk, and may thus bring discredit on the dairy. This point must be carefully attended to, especially when the cows are stall-fed on green meat.

The water, together with a sponge, or cloth, is contained in covered pails which the dairy-maids carry with them, and use as stools to sit upon.

When the dairy-maids say that a cow has fallen off in milk, and is scarcely worth the trouble of milking, the milk must be gently warmed, to try if it will curdle: if not, the milking must be continued, in order that the cow may not become accustomed to remain long without giving milk. The milking of every cow must, however, be discontinued about a month before she calves, even though she should yield a quart of milk, otherwise she will be too much exhausted.

Some persons maintain that cows yield a greater quantity the oftener they are milked: but this opinion is not borne out by careful experiments. On the contrary, it has been proved that as much milk is obtained when the cows are milked twice, as when the milking is performed three or four times a day: some persons have, in fact, obtained a greater quantity of milk, but not of such quality as to yield more butter. It is only when the secretion is most rapid, and such that the udder cannot contain all the milk, but allows some of it to drop out spontaneously, that a third milking becomes necessary.

The first portion obtained at each milking is not so rich as the last: but I have never observed so great a difference between the two portions as some persons pretend to have remarked. In places where one part of the milk is sold, and the rest made into butter, these two portions are sometimes separated, the latter only being taken to make butter.

When milk is to be sold fresh, it is important to keep it at a low temperature; not, however, below the freezing point. If the fresh milk be carried to a town a mile or two off, the produce of the evening milk is usually devoted to this purpose, and carried away as soon as drawn, the vessel containing it being immersed in cold, and sometimes in iced water; the carriage is performed during the night, so that the town may be reached early in the morning. At short distances from town, the morning milk may also be added.

This mode of disposing of milk is looked upon as the most advantageous of all. This is, in fact, the case, though not without limitation: for the system involves expenses, details, and superintendence, which are not in the power of every farmer. It is certainly the most convenient method, for those who can sell their milk as soon as drawn to a retailer, who takes it away, and is accordingly allowed a profit to recompense him for his trouble. In localities where there is a town-market for fresh milk, there is generally, also, an opportunity of selling fresh butter for the table: and the price of this butter is such as to yield a profit at least equal to that which can be obtained by selling the milk directly. In the country, the quantity of fresh milk which can be sold is but trifling: but there is sometimes an opportunity of selling skimmed milk, whey, and butter-milk, to advantage.

In order to make butter perfectly good and fit for keeping, it is necessary to make one's self acquainted with the process in all its stages.

A good milk-room is an essential condition. It is usually formed under-ground, for the sake of maintaining a proper and equable temperature. The ground is covered with stone slabs, and the false floor thus formed is made to incline to one side, so that the water with which it is continually sprinkled, and that used for cleaning, may drain off into a cistern, and be carried away. The cellar, or milk-store, should have gratings, or apertures on two opposite sides, so that the air may circulate freely through it. These apertures are generally so disposed, that the draught of air may be felt not only in the upper part of the room, but also near the ground. The lower apertures must, however, admit of being shut when the wind is so high as to occasion risk of disturbing the milk-pails placed on the floor. The milk-store must be large enough to admit of the vessels being placed side by side, and not one upon the other: at all events, this latter arrangement is considered disadvantageous in the best managed dairies of Holstein. It is best to place the milk-pails directly on the floor, for it is there that the temperature is most uniform.

A proper temperature is of the greatest importance in causing the milk to cream. If the temperature be too high, the milk turns sour before the cream collects on its surface, and then the cream will not separate. When the temperature is too low, the separation of the cream takes place very slowly. The most suitable temperature is between 12° and 15°. The former is the proper degree of heat for summer, and the latter for winter. To obtain perfectly good butter, we must be very careful not only to keep the vessels and utensils, but also the air of the room perfectly pure. There is no liquid more susceptible in this respect than milk: foreign matter, and exhalations of all kinds, may impart to it a bad taste, an unpleasant smell, and various other defects.

The disposition of milk to become glutinous and stringy often arises from nothing but a vitiated state of the atmosphere, though it may also proceed from some disease in the cow, which may be communicated to the whole mass of the milk. The appearance of a blue colour in the milk, or of violet spots on its surface, is in most cases produced by impurities in the air. It is probably a kind of mouldiness, developed on the cream as soon as it comes to the surface. This evil has, after many trials which have come to my knowledge, been cured by airing the cellar well, after it has been fumigated with chlorine or burning sulphur, the various utensils of the dairy being also exposed to this fumigation.

The milk, as soon as drawn, is poured through a sieve into the pails, in order that the cream may collect on its surface. The sieve must not be of woollen or linen cloth, but of hair, and kept in a state of perfect cleanliness.

The vessels in which the milk is put to cream are of metal, earthenware, or wood. Those of metal, especially tin, appear from many trials to be decidedly the best for skimming the milk; but they are too costly for use in large rural establishments. Vessels of clay or porcelain are more easily kept clean than wooden ones, but they are too fragile. Attempts have been made to case them in wood, for the purpose of increasing their solidity. They should be well glazed, as otherwise, the milk when sour, will penetrate the clay: but glazes containing oxide of lead must be avoided, because sour milk would dissolve a portion of the lead; the quantity thus dissolved would, however, be very small. According to Wistrumb's experiments, the danger arising from this cause is not so great as some persons suppose. Glass and porcelain vessels are too costly, and serve only to make a show. In large dairies, wooden vessels are most commonly used; and when care is taken to clean them properly, and not expose them to the air, they are unexceptionable. Especial care must be taken to prevent their being contaminated by acid fermentation; for this purpose they must be washed from time to time with the lye of wood-ashes, and always scoured with water and a brush after being used. These vessels are usually made by coopers; but they are sometimes formed of a single piece of light wood, and flattened at the bottom, in order that they may stand well. The latter are decidedly preferable, both because they have no joinings, and are therefore more easily kept clean, and likewise because they expose a larger surface of liquid to the action of the air.

In all cases, the milk-vessels should be as shallow as possible, in order that the cream may rise quickly to the surface, and be more easily separated from the milk. Deep vessels, of narrow surface, are altogether disadvantageous and defective.

Opinions are divided respecting the proper time for skimming the milk. Some persons allow it to curdle and turn sour, before they skim, thinking to obtain a larger quantity of cream by so doing. But in Holstein, where the art of making butter is most thoroughly understood, the contrary opinion is entertained, and the cream is taken off before the slightest acidity is developed. The cream is considered ripe when the thrusting of a knife into it no longer causes any milk to rise to the surface.

The latter method is decidedly preferable; for it is a demonstrated fact that acidity not only does not assist the separation of the cream, but, on the contrary, stops it when once begun, and farther, that butter made from sweet cream, besides having a more agreeable flavour when fresh, is better adapted for keeping, and less exposed to become bitter. The slightest degree of acidity causes the mixture of cheesy particles in the cream; the layer to be taken off becomes thicker in consequence, but the quantity of cream is not really increased. It is of great importance to seize the moment when all the cream is collected on the surface, but no acidity is yet apparent. The time at which this effect takes place is subject to considerable variation, according to the state of the atmosphere. At a temperature of ten degrees (centigrade), it may be expected in thirty-six hours; at a higher temperature, it takes place in sixteen hours; and during stormy weather, in twelve or even ten hours. In the Holstein dairies careful persons are set to watch the milk during the night, in order that they may ring up the dairy-maids as soon as the precise time is arrived; this they ascertain by the signs already spoken of.

The cream is taken off by means of a wooden spoon shaped like a shovel.

The butter should, if possible, be made as soon as the cream is taken off. In well-managed dairies, only the portions of milk obtained in one day are mixed together. In small establishments, where butter is made only once in two or three days, the cream must be kept in earthen vessels, and as fresh as possible.

Butter is separated from the surplus of cream with which it is mixed by a mechanical movement, produced in various ways. There are two sorts of *churns:* one high, narrow, and fixed; the other shaped like a barrel. The latter either turns upon a fixed axis, having wooden vanes attached to it; or the barrel is fixed, and the axis with its vanes turns within it, being moved by a handle. Barrel churns have been extolled above their real merits. In order to estimate their value properly, and in general to form an idea of the points to be attended to in making it, it is necessary to know how this substance is formed and separated.

The fatty part of milk is not actual butter; the latter substance is formed by the action of the air upon the cream, in fact, by the absorption of oxygen. For this reason, the air must have free access to the cream, and be renewed as often as possible in the vessels in which it is stirred. It has been shown, by direct experiment, that oxygen is the principle most actively concerned in producing the change; for it has been found that the butter appears more quickly in proportion as the air is more charged with oxygen, and that when that substance is not present, the formation of butter does not take place.

In this respect, the high, narrow, fixed churns have the advantage over those which are barrel-shaped, because the latter must be closed, and the oxygen contained in the confined portion of air is soon consumed; whereas fixed churns allow a sufficient quantity of air to enter, and moreover the air is constantly renewed in them by the agitation which effects the separation of the butter.

But these pump churns are likewise preferable in another point of view; the oily particles hardened by the air and transformed into butter, still swim in the liquid in a state of minute division, and must be collected by agitation into larger masses. Now, in churns which turn upon an axis, the motion is not sufficiently powerful, for, although the whole of the liquid is thrown into a revolving motion, it is not beaten and stirred up thoroughly as it ought to be. But in fixed churns the beating up and down produces a continual displacement of the milky particles, and thus brings the buttery portions into contact. The long fixed churns have also the advantage of being more easily cleaned than those which revolve.

But as the beating or pumping motion is laborious when performed by unassisted manual strength, particularly with large quantities of liquid, various mechanical contrivances have been devised for diminishing the labour: they consist, for the most part, in attaching the rammer, by a moveable connection, to the arm of a lever. The butter is generally stirred in two churns at once, so that the rod descends in the one at the same time as it rises in the other. Motion is given to the beam either by a heavy hammer, which is moved backwards and forwards by two men, and, when once in motion, goes on without difficulty, or by means of a wheel whose circumference is loaded. In the very largest dairies, the machine is set in motion by horses or oxen. This method is, moreover, advantageous, inasmuch as it gives regularity to the motion, and then the butter is formed in a better manner than when the motion is sometimes fast and sometimes slow.

In the preparation of butter, a point of equal importance with the preceding is the maintenance of a proper temperature. When the cream is too cold, the buttery particles become too hard, and not glutinous enough to stick together; too high a temperature, on the contrary, makes the butter very soft, and then the clots become divided during agitation, and mix again with the milk. If the cream be too cold, the churn must be heated either by putting it in a warm place, or mixing a little warm water with the cream; when, on the other hand, the temperature is too high, it becomes necessary to cool the churn by placing it in cold water, or, if possible, in ice.

There are, however, other causes of difficulty in the preparation of butter. The milk of cows in a very advanced state of pregnancy is not easily converted into butter. The process may sometimes be facilitated by the addition of a little salt; no injury will be done by the slight degree of saltness thus imparted to the buttermilk. It is also said that a piece of alum put into the strainer produces a good effect. Much praise has been bestowed upon a powder composed of dried *sorrel-leaves, hore-hound, yarrow, and nettle;* three handfuls of each, and half a pound of flowers of sulphur. A handful mixed with a pound of vinegar made from beer is given to each cow three times a day. The sulphur and beer-vinegar are the really useful constituents of this mixture. Sugar, ashes, or soap, falling into the cream, prevent the butter from forming. The common people attribute this accident to witchcraft, and resort to all sorts of superstitious ceremonies to obviate it as well as other defects in the milk.

When butter is to be coloured, the colouring matter must be placed in the churn. With us, the colouring is usually given with carrot-juice. In Holland, they use *marigolds*, which for this purpose they gather fresh; they then put them into a stone vessel, press them together, cover them completely, and keep them in cellars. A deeper colour is given by another material; an ounce of which, of the size of a pea, is put into thirty pounds of cream the evening before the butter is made.

Butter, as soon as made, should be separated from its milky residue, for the latter being much disposed to ferment, would infect the butter and give it a bad taste. In Holstein, butter is not washed, but very carefully kneaded, washing being considered injurious. For my part, I prefer washing, provided the butter be well worked and kneaded afterwards. No moisture should be allowed to remain in it: the portion which cannot be got rid of is absorbed by common salt, and can no longer either ferment or cause fermentation. It is probably for this reason that butter for keeping must always be salted: the less butter is cleaned the more does it require salting. A pound of salt is added to five, ten, or twenty pounds of butter.

The principal cause of butter acquiring a bad taste and smell after a while is undoubtedly that a certain portion of cheesy matter remains in it, and enters into a kind of putrefaction. The less there is of this matter, the longer will the butter keep. In many places, badly cleaned butter is melted to make it keep longer, the cheesy parts being separated by this fusion: but butter thus melted never preserves the agreeable flavour of fresh butter, and can only be used for culinary purposes.

When butter is kept in tubs or earthen vessels, it must be packed as closely as possible, and no interstices or vacant places left, for the butter quickly spoils around these interstices, and the evil spreads through the whole tub. In large establishments, it is considered essential that a tub be filled with butter made all in one day.

Skimmed milk is used in various ways; it is sometimes mixed with butter-milk for human food; sometimes used in making bread; sometimes to make cheese; or, lastly, to feed pigs. These animals, as we shall hereafter see, are also fed upon whey.

The whole of the milk is sometimes used, unskimmed, in making butter; and many persons consider this method advantageous, especially when only the richer half of the milk is used. But such butter will not keep long, and it is much less rich than common butter, because it contains a larger quantity of cheesy matter.

Cheese-Making.

The preparation of cheese of first-rate quality involves a greater number of details, and requires more attention, than that of butter. But it is in many cases much more profitable; indeed, the profit of the dairy is often doubled by it. In former times, all our good cheese was brought from foreign countries, and had to pass through several hands, so that we were obliged to purchase it at a price considerably above prime cost. In undertaking the making of cheese, however, we must not forget that good, sweet cheese requires to be kept for a year, or even a year and a half, before it becomes fit for sale; and consequently that it employs a capital, the interest of which must be paid, as well as the rent of store-houses for keeping the cheese; moreover, there are but few rural establishments which have this capital at disposal.

There is an almost endless variety in the modes of preparing cheese, and this variety is the principal cause of the differences of taste, smell, solidity and colour, which cheese exhibits. It is true that the kind of pasturage on which the cattle are fed, the manner in which they live, and the climate, may have some effect on the quality of cheese, so that they may vary in taste, even when prepared in the same manner; indeed, even in countries where cheese is made in large quantities, one locality is admitted to have the advantage in some respects, whilst in others, the superiority is awarded to cheese made elsewhere. This difference is almost universally attributed to the nature of the pastures, and to certain plants which grow upon them. But it is also certain that the most trifling difference in the mode of preparation, will give character which connoisseurs are sure to detect; and in localities famous for their cheese, the women who make it have peculiar modes of proceeding, which they refuse to communicate to others. Such differences are, however, inappreciable, excepting to very refined palates.

When connoisseurs in cheese are accustomed to particular sorts, and require that all imitations shall have exactly the same flavour, and other characters, as the originals, it becomes difficult to satisfy them; but such pretensions are founded rather on obstinacy than on real superiority of taste. There is every reason to believe that we are capable of making cheese which, even if not precisely similar to the best Cheshire, may nevertheless be superior to it in flavour; and if we can only succeed in giving to our cheese a quality proportionate to its price, we shall not fail of obtaining a market for it. We must, however, especially in commencing the undertaking, endeavour to approach as closely as possible to some kind of cheese in high estimation, either for taste, form, or internal appearance.

The innumerable varieties of cheese are classified according to the following properties:—

1. With regard to richness, we have,

(*a*). *Very rich* cheese, made from morning milk as it comes from the cows, and the cream of the evening milking.

(*b*). *Rich* cheese, made from milk just as it comes from the cows.

(*c*). *Poor* cheese, made with skimmed milk.

But there are degrees of richness according to the quantity of cream used for the first variety, and the quantity taken off the milk from which the third is prepared.

2. A distinction is made between *sweet* and *sour milk* cheese, accordingly as the milk and cream from which they are made are used fresh, or allowed to acquire a certain degree of acidity.

3. Another distinction is between pressed and unpressed cheese. It is only by pressure that cheese can be separated from all the whey that is mixed with it. Now the whey, by fermenting, imparts to the cheese a peculiar pungency, and a disposition to alter its consistence, and,

especially in a damp atmosphere, to melt, and be converted into a kind of viscous liquid. Hence, the more carefully the raw material is worked, and the oftener the cheese is pressed to get rid of the whey, the sweeter and better adapted for keeping will it become. The sweetness of Gloucester and Cheshire cheese arises chiefly from the repeated and careful working bestowed upon it, and the strong pressure to which it is exposed for expelling the whey. But cheese thus prepared becomes almost as tough as leather, unless it contains an abundance of fatty particles.

Unpressed cheese must be consumed soon after it is made, or it will quickly attain a state of putrid fermentation. When this happens, the cheese is worked anew, put under the press, and mixed with cream and butter; the progress of putrefaction is checked by wrapping it in cloths moistened with beer containing a large quantity of hop, or with wine; a quantity of hops, or other aromatic substances, are placed between two of the cheeses, and the drying is repeated. It is in this manner that the strong, pungent cheeses so much esteemed by some persons as a stimulus to the appetite are prepared.

4. Cheese is also distinguished according to the manner in which the milk is curdled, and the substances employed for producing this effect.

Milk is curdled either after being warmed, or at its natural temperature, (26° *centigrade*), or after cooling.

The warmer the milk, the more readily does it curdle, the quantity and the pressure to which it is subjected being the same. But if the milk be too warm, and curdle too quickly, the cheese will be hard. The fineness and delicacy of the cheese-paste are greater in proportion to the freshness of the milk. Cheese made from milk which has curdled slowly, does not become ripe enough for sale so quickly as that which has been made to curdle rapidly.

Coagulation may be effected by simply warming the milk when it has acquired a slight degree of acidity; but this method is adopted only with sour-milk cheese. It is known that all acids coagulate milk. Mineral acids are often used for this purpose, especially the hydrochloric; the effect is also brought about by means of vinegar, and different vegetable substances, containing an acid principle, or tannin, such as tamarinds, sour fruits, oak, willow, and alder bark. The *yellow bed-straw*, or *cheese-rennet* (*Galium verum*), has been long recommended as an excellent substance for curdling milk: this property has, however, been lately called in question.

But the rennet most generally used is the stomach of a sucking-calf, and the substances contained in it, after it has been well cleaned. The last of the four stomachs is the one used for this purpose.

The modes of preparing and keeping these calf-stomachs vary to a great extent: many persons maintain that the slightest difference in the preparation has great influence on the nature of the cheese. Celebrated cheese-makers, therefore, often make a secret of their mode of preparing the rennet. Marshall, in his description of the rural economy of Gloucestershire and the southern counties, has detailed various processes adopted for preparing the rennets in those counties of England most celebrated for their cheese, viz., Gloucestershire and Cheshire, in which he prolonged his stay, for the purpose of acquiring a knowledge of these processes: this part of his writings deserves to be translated. I do not think, however, that slight differences in the rennet have so great an influence on the quality of cheese, and Marshall himself seems to have come round to this opinion.

The following is one of the processes most frequently adopted: The stomach of a sucking-calf is opened, and the curdled milk taken out; the latter is cleaned, particularly from hairs which may be found in it, and washed with cold water till it becomes quite white; it is then squeezed in a cloth properly adapted for drying it, spread out, and carefully rubbed up with salt. Then the stomach is also washed in cold water, rubbed with salt, and the previous preparation enclosed in it; the whole is put into a pot, and covered with salt. As many stomachs as can be collected in a month are put together. The rennets thus prepared must remain for a year in the vessels before they are used; and when they are to be used, one of the vessels is opened, and emptied, and its contents carefully pounded. The yolks of three fresh eggs and a small glass of good cream are then added. It is usual, after mixing the whole well together, to throw in a small quantity of spice, flower, and seed of nutmeg, a clove, and a little powdered saffron. The whole is then again put into the bag, and hung up in a proper place. Next a strong mixture is prepared, boiled, and left at rest as long as required; $8\frac{1}{2}$ oz. of rennet taken out of the bag are put into it, four or five walnut leaves are also put into it, and the whole left at rest for a fortnight.

Another mode of proceeding is to take the stomach of a young calf, together with the coagulated milk contained in it, and carefully wash the latter. The stomach is then also carefully washed, and left in salt for three days. Five or six eggs are then boiled in water till they become hard, cut up small, and mixed with the curdled milk: the whole is then replaced in the salted stomach, hung up in the smoke for three weeks, and afterwards in the open air. When it is to be used, a piece is cut off, mixed with a little milk, and poured into that which is to be curdled.

A third process consists in taking three or four stomachs of calves, removing the coagulated milk, washing and kneading it with a handful of barley-meal and an equal quantity of new bread and salt. The stomachs themselves are not salted: they are merely scraped a little, and the matter thus separated from them joined with the mixture just described. The whole is then placed in a stove or earthenware vessel, with a little salt above and below it, and kept in a cool place.

Instructions on the making of various kinds of cheese will be found in the following works:—Of Swiss cheese in the third part of Witte's work 'On the Breed of German Horned Cattle:"* of Cheshire cheese in the

* See also the excellent work entitled, "Des Fruitières," by Ch. Lullin.—FRENCH TRANS.

"Archiv der Agricultur Chenie of Hermbstadt:" of Lamburg cheese in the "Annalen des Ackerbaues," bb. xi. s. 652: of various kinds in the "Encyclopædia of Krunitz, vol. xxxv.: see also Voss, "Anweisung-Rahm-und Fett-Käse welche dem besten Engbshen und Hollandeschen gleich Kommen zu bereiter." Altona, 1807. "Vollständige und deutliche Anweisung zur Bereitung des beruhmten Englischen Chester Käses." Pirna, 1803. Twamley—"Anweisung Englische Käse zu machen, aus dem Englischen ubersetzt mit Anmerkungen." Frankfurt am Main, 1787.*

I have no actual experience in the preparation of cheese, but, on the other hand, I have the most convincing proofs that in this country, even with the milk of stall-fed cows, and during winter, the most celebrated cheese may be imitated so closely, that the difference shall be inappreciable even to the practised taste of a connoisseur. And even if cheese thus prepared should be somewhat different from that which we seek to imitate, it would not on that account be necessarily worse, it might indeed be superior. But we must not attempt to make rich cheese with skimmed milk, sweet cheese without pressing out the whey, soft cheese without paying great attention to the temperature, or generally good cheese without observing the strictest cleanliness. We must not allow ourselves to be disgusted with a single failure: and to judge of all the cheeses that are fit for keeping, it is necessary to wait for the time when they become eatable, and meanwhile to adopt the best possible means of preserving them, and among these an airy cheese-cellar is absolutely necessary. As all these matters are left to the management of women, it is necessary that the superintendent

* In Switzerland there are several kinds of cheese very different from one another. The most esteemed of all is certainly the Gruyères cheese; most of the others resemble it more or less, the differences arising rather from the nature of the pasturage than the mode of preparation. The Urseren and Bellelay cheeses have quite a different taste. In the canton of Glavis they make a kind of cheese containing aromatic herbs; it is very high-flavoured, and much esteemed by some persons. Its local name is *shaapzigner*; a name which implies that it is not a cheese properly so called, but a *seret*.—French Trans.

take a lively interest in the success of the undertaking; without this it will rarely turn out well.*

FATTENING OF HORNED CATTLE.

In countries where grain is cultivated in large quantities, there exists a deep-rooted opinion that the fattening of horned cattle is positively disadvantageous, excepting in large brandy distilleries. This opinion is, however, often unfounded. Local circumstances may alter the relative value of fattening, according to the results afforded by maintaining cattle for other purposes.

In calculations which profess to show that this branch of economy is unprofitable, the question is not correctly stated; the food given to the cattle being estimated at the market price, instead of at the cost of production. Every one knows that the maintenance of cattle is indispensable to grain cultivation: the influence of this maintenance on the produce of grain has, indeed, been developed in several parts of this work. Moreover, in

* In Switzerland and Italy, cheese-making is not entrusted to women: they are rarely, indeed, employed to milk the cows, especially for large dairies. There is no doubt, however, that they would be very well adapted for both these duties if they were accustomed from their youth to the necessary regularity and exactness. In the countries just mentioned, the cheese-maker is one of the most important persons on the farm, for upon his skill and attention mainly depend the success and quality of the cheese; the produce of which forms one of the most important sources of income.—FRENCH TRANS.

Our author might have noticed in this place, that another product called *serac* or *seret*, not so rich as cheese, but nevertheless constituting a useful article of food, is obtained after the fabrication of cheese, by boiling the whey and adding fresh rennet. In the neighbourhood of towns, this substance is usually sold fresh, and appears in various forms on the tables of the rich. When salted like cheese it keeps for a long time; and though not, perhaps, so good as cheese, is still a wholesome kind of nutriment, and within reach of the poor people. The quantity of whey is, however, diminished by this preparation; and I am not sure but that in the greater number of cases, when the cost of labour and other expenses have been deducted from the value of the *seret*, it may not be more advantageous to have the whey consumed by pigs, just as it is obtained after cheese-making.

The author might also have spoken of the preparation of milk-sugar, which, by the re-opening of maritime communication, has fortunately been reduced to the small quantities required for pharmaceutical purposes.—FRENCH TRANS.

the greater number of cases, we cannot dispense with horned cattle. The real question at issue, therefore, is, which kind of cattle is to be preferred, and, with regard to horned cattle in particular, whether the quantity of fodder and pasturage devoted to them can be more advantageously consumed by milch cows or fattened oxen.

This question merges into the two following:—

(*a*). What is the proportion between the quantity of fodder consumed by a milch cow during the whole year, and that which an ox consumes in the time required for fattening him?

(*b*). What is the profit of an ox during the time that he is fattening, and that of a milch cow during the whole year?

We have already spoken of the quantity of fodder consumed by a milch cow, and the differences observed with regard to this matter. That required for an ox put up to fatten likewise varies according to the size of the animal, and the quantity of flesh and fat which we wish to give him. But it is perhaps easier to fix a tariff for each particular case of fattening than for those which relate to the management of milch cows. In localities where fattening is practised to a considerable extent, the daily allowance which ought to be given to an ox of a certain breed is determined with tolerable accuracy. Hence in these countries it is usual to fix the weekly price which a butcher or cattle-dealer is to pay for the feeding of an ox: this price, however, is subject to certain modifications according to circumstances of place and time. Thus it is easy to calculate beforehand, and resolve the question for oneself: the result shows that fodder is often better repaid by fattened oxen than by milch cows, especially when the short time of fattening is compared with the maintenance of a cow for the whole year, and the care of the dairy: to this we must add, that the fattening of oxen during winter takes place at a season when labour is abundant; whilst the maintenance of cows continues during summer, when labourers are often difficult to obtain. In many cases, also, it must not be forgotten, that the capital devoted to fattened oxen returns in four or five months, while that expended on milch cows is always floating.

On the average we may reckon that an ox, while fattening, consumes almost as much fodder as will suffice for a cow during the whole year: but at the same time the dung yielded by an ox whilst fattening is equal to that which a cow furnishes in an entire year, and perhaps of better quality; besides, this dung is obtained at a time when it can be easily carted.

Even if it be not thought advantageous to make fattening the basis of the economy of live stock, it may, nevertheless, be very useful as an accessory branch. When the whole economy of fattening is once thoroughly understood and organized, it will always be much easier to regulate the number of animals put up to fatten, according to the annual quantity of fodder, than that of any other description of cattle. We must be careful not to increase the number of animals maintained beyond that which we are certain of being able to support, even in bad years; the excess of fodder obtained in good years may be employed in fattening cattle, which are always easily procured from without, even if we have none of our own that we wish to improve. It is commonly more profitable to sell fat than lean cattle.

Whoever would undertake the fattening of a large number of cattle, must endeavour to acquire experience in the knowledge and valuation of them, and of all that relates to this branch of commerce, or at least must avail himself of the direction of a well-informed and intelligent man. The choice and valuation of cattle require a certain practice of eye, and still more a certain tact of hand, which cannot well be acquired without long practice. It would, therefore, be useless to describe them here. They can only be obtained by actual inspection and comparison of a large number of cattle. Great facility in valuing cattle, and certainly in buying and selling, as well as in the whole process of fattening, are obtained by the use of a machine for weighing living animals. Such an instrument is neither expensive nor complicated. A box, formed of boards joined together, and of sufficient length and breadth to allow an ox to stand upright in it, is suspended by a chain from the shorter arm of a balance-beam. There is a door for the animal to enter; and on the other side a rack, in which a little hay is put to induce him to go in. The box rests firmly on the ground. The other arm of the balance-beam, which may be of wood, is ten times longer; a dish is suspended from it for holding weights. The equilibrium should be established by means of this dish in such a manner, that the addition of the smallest weight shall raise the box when empty. The longer arm of the beam being ten times as long as the shorter, any weight placed in the dish produces a tenfold effect upon that which is in the box: the tenth of a pound in the former will support a pound in the latter, and one pound will support ten. The weight of the beast is ascertained as soon as the box begins to move in the slightest possible degree: it must not be lifted for fear of frightening the animal. Such an instrument may be placed in a stall, the pivots on which the beam turns being suspended between two beams: it may also be put up in a yard, but it will then require a stand to support it. A machine of this description is also very useful for weighing fodder.

Some persons profess to determine the weight of a beast by the dimensions of particular parts, and the use of certain arithmetical formulæ. But, even supposing this method to be applicable, with tolerable certainty, to the greater number of cases, the rules in question can be adapted to a particular race only, and one that is well fixed; so that every breed must require distinct formulæ practically determined. That such is really the case has long been known in England. In the actual state of things it would be very hazardous to rely on such data.

According to the experience of the English, the weight of an animal in butchers' meat may be estimated with tolerable accuracy by its weight while alive.

By weight in butchers' meat, we mean that which a beast weighs when hung up, with his head, fore-legs, entrails, and suet removed—the weight in net flesh, as it is called. But for this purpose the health and condition of the animals must be taken into consideration. For an ox not absolutely lean, but still not fattened, Procter Anderdon gives the following rule:—Take half the weight of the animal while alive, add to it four-sevenths of the whole, and divide the sum by two; the quotient will be the weight of net flesh. For example, suppose a live ox to weigh 700 lbs.—

Half of 700 lbs.	350 lbs.
Four-sevenths of 700 lbs.	400
	750 lbs.
Half sum	375 lbs.

In this case 20 lbs. would yield $10\frac{5}{7}$ lbs. But when oxen are a little fatter it has been found that 20 lbs. commonly yield 11 lbs., and when they are completely fattened 12 or $12\frac{1}{2}$ lbs.; for, as an ox gets fatter, the proportion of his flesh to the refuse becomes greater.

Finally, in fattening cattle, the greatest regularity must be observed in distributing the food, cleanliness, &c.; matters of which I shall speak under the head of each description of fattening. In this place I content myself with recommending that no one undertake the fattening of a large number of cattle, unless he can have an eye to them himself; or, at the least, unless he can obtain the services of a man deserving of the most implicit confidence, and thoroughly devoted to this branch of economy.

Summer-fattening is divided into pasturage and stall-feeding on green-meat. The former system requires very rich pastures; which, for this reason, are called *fattening-pastures.* There is a dispute in England respecting these pastures, whether it is better to place the cattle on the whole of the grazing land devoted to the herd, leaving them at liberty to roam over it; or to divide the pasturage into a number of small enclosures, admit only a few animals to each, and use them alternately, so as to leave time for the grass to grow again.* Most persons are in favour of the latter method, which is supported by the strongest reasons. In the low countries of the Lower Elbe, it is an established custom in most localities to have the meadows grazed and mown alternately. In spring, one enclosure or piece of meadow-land, surrounded by ditches, is devoted to the cattle, whilst another is reserved for hay-making. After the crop has been taken from the latter, cattle are turned in upon it; whilst the former is left to produce grass for mowing. In other cases one piece of land is used exclusively for pasturage, but the cattle have likewise the benefit of the other after the hay-crop; the latter then serves as a supplement to the former towards the end of summer, when vegetation begins to slacken.

In these low countries, an acre per day is the estimated quantity of land for a large ox of the native breed; which will attain the weight of 1000 lbs., net flesh. This acre contains 450 perches each, 16 feet square, and is equal to 3¼ of our acres; but the same extent of ground suffices for 1½ small oxen of the Jutland breed. It is usually reckoned that the fattening of a large ox yields a profit of 8 Frederic's-d'or, and that of a small one 6: the latter is regarded as the more advantageous. It is not uncommon to find one or two horses among horned cattle; sometimes, also, sheep of the low country breed: the latter crop the finer herbage, the former that which is coarser and grows on the richest spots. This method is considered economical.

Thistles soon spring up vigorously on pastures of this description; they are not eaten while young by the cattle, and they prevent the grass which grows around them from being cropped. Every careful farmer will, therefore, mow them down: when withered and half dry, cattle willingly eat them.

It is of great importance to remove everything which can disturb the cattle whilst grazing. No one should

* See the "Annalen des Ackerbaues," No. 112, A.

therefore be allowed to enter the enclosures; and particular care must be taken to keep dogs out.

When there are no trees in the enclosures, stakes with notched edges are fixed in the ground, for the cattle to rub themselves against. Good and convenient watering places must be provided. Sometimes, however, it becomes necessary to draw water from wells, and give it to the cattle in troughs.

Fattening cattle may also be pastured by the tether, on fields where fodder-plants are cultivated: the mode of proceeding is the same as that already described for cows.

Green-feeding in the stall is not usually adopted for fattening cattle. I am, however, acquainted with various cases in which it has been successfully practised. Oxen will get very fat on green clover, if they are plentifully supplied with it. But an ox eats from 200 to 250 lbs. of green clover per day, in addition to good straw, which he will readily eat between his meals. If he can be partly fed on hay or dry clover, the green-feeding will, doubtless, be still more profitable to him: this method diminishes the excessive relaxation of the bowels which otherwise ensues. A mash, containing oil-cake or a little ground corn, has been found particularly useful, especially towards the end of the fattening.

This summer-fattening on green-meat in the stall can, however, be advantageous in a small number of cases only, because at the season of its termination there are usually a large number of pasture-fattened cattle in the market. The clover intended for fattening the cattle may be more advantageously made into hay, and used for winter feeding.

One method of fattening cattle in the stall, both in summer and winter, is to feed them on the refuse of the brandy distillery. In countries where the quantity of meat consumed is but small, this mode of fattening is almost the only one adopted; it renders the distillation of brandy a rural rather than a town occupation; because the townsman cannot pursue it to so much advantage for want of straw, and the means which the cultivator possesses of employing the dung. When the cultivator begins to devote himself to this branch of economy with the same degree of industry as the townsman, and the government permits the exercise of each description of industry in the locality best adapted to it, the town distilleries are unable to compete with those in the country. It is said that the refuse of 10 metzen of grain which has passed through the still, with cut straw and a little hay, affords, on the average, sufficient daily nourishment for fattening an ox. Where the quantity distilled amounts to 6 scheffels per day, $9\frac{3}{5}$ or even 10 oxen per day may, therefore, be put to fatten. If the oxen be sold at the end of 20 weeks at a profit of 20 rix-dollars per head, or 200 rix-dollars for the whole, and the quantity of food consumed in this time is 840 scheffels, the cost of the brandy is diminished by 5 groschen 8 deniers per scheffel. The farmer can very well give the hay and straw for the sake of the dung; but the townsman cannot. The profit, however, often amounts to more than 30 rix-dollars; and it is not uncommon to pay from 1 rix-dollar 8 groschen to 1 rix-dollar 12 groschen per week for the feed of an ox.

The refuse of the still is usually poured upon cut straw, to be given to the oxen, which therefore receive part of their food in the liquid form. They are said to fatten most quickly when this food is given to them warm. Oxen thus fed are in a constant sweat, and hence it becomes necessary to protect them from wind coming through cracks, which would check the perspiration. Cattle would not long preserve their health on such diet; but they can support it during the fattening time.

The farther, however, the production of alcohol is carried by complete vinous fermentation, the more does the refuse of the distillation lose of its nutritive principles; so that cattle often fatten better, the less completely the operations of the still are conducted. The Brabançons, although they know the superiority of distilleries conducted on the Dutch system, still keep to their old method, notwithstanding its defects, for the sake of their cattle. In the neighbourhood of the Rhine, the distillation of brandy from grain is no longer found advantageous, either on account of the rise in price of grain, or of the competition of brandy made from wine-lees; the distillation from grain is however continued, because the manure which it affords renders it one of the pillars of agriculture.

The residue of other kinds of raw material ought to be proportionate to the quantity of brandy which they yield. If, for example, $3\frac{1}{3}$ scheffels of potatoes yield as much brandy as 1 scheffel of rye, the residue of the latter preparation will contain the same proportion of nutritive matter. Some persons, however, say that they have found it less substantial.

In fattening on distillers' refuse, as well as in every other mode of stall-fattening, care must be taken to maintain a uniform, and in winter a somewhat high temperature. Light may and must be intercepted, for just in proportion as it keeps up the health of cattle so does darkness accelerate the attainment of the required degree of fatness, which is in reality a kind of disease: this effect is due partly to physical action, and partly to the repose and inclination to sleep which darkness produces.

Cleanliness and a good supply of litter are highly beneficial. The cattle then lie down during the greater part of the day, only rising to eat. Keeping the skin clean, and currying, visibly accelerates fattening; the animals plainly manifest the agreeable sensation which the operation affords to them. The old hair falls off as soon as the fat begins to form, and new is produced. At this time in particular, currying must not be neglected; the trouble which it occasions will be amply repaid. Though the advantage of this treatment to milch-cows may yet be doubtful, there is no question about the benefit which it confers on fatted cattle. The instrument used for the purpose is a wooden comb, fitted with a handle to facilitate its use.

The utmost regularity must be observed in the hours of feeding, and the quantity of food given at each meal. Animals acquire a most exact knowledge of time. This is remarkably conspicuous in old beasts of draught, which, when the proper hour of rest arrives, refuse to work, and want to go to the stall, or the field in which they graze. Stalled cattle become restless when their feeding-time is not punctually observed, though very quiet before the time arrives. They also know the quantity usually given to them: when they have received and eaten it, they go to rest; but if they have not had their full allowance, they continue restless. The repose and contentment, the happy freedom from anxiety, arising from the certainty of receiving their food in proper time and measure, contribute so much to the fattening of cattle, that a much more plentiful supply, given irregularly, cannot make up for the want of order. The hours for feeding and the quantity of food may be variously regulated: but a system once adopted should be steadily adhered to.

In countries where hay is abundant, it is sometimes used as the sole winter food. An ox, brought to the weight of 700 or 750 lbs., and receiving 40 lbs. of good hay daily, increases in weight 2 lbs. per day, or 14 lbs. per week. If a pound of meat be worth 2 groschen, the ox increases in value at the rate of 1 rix-dollar 8 groschen per week: hence, 1 quintal (110 lbs.) of hay will procure a return of 12 groschen, the value of the dung being set against that of straw and attendance. Hence, in all cases in which this price of hay is such as to satisfy the cultivator, fattening will not be so inconsistent with good management as some persons assert.

But various experiments made in this country seem to show, that if, instead of 30 lbs. of hay, an ox receive 60 lbs. of potatoes and 10 lbs. of hay, or 420 lbs. of potoes and 70 lbs. of hay per week, he will improve in condition, and increase sensibly in weight and fatness. As, however, he will eat a little more straw, we will suppose that the profit of this mode of fattening is not greater than the preceding. The value of 70 lbs. of hay per week amounts to 7 groschen. The 420 lbs. of potatoes which he receives per week will, therefore, be paid for at the rate of 21 groschen and 1 scheffel, or 100 lbs. of potatoes will be consumed, at the price of 5 groschen. The potatoes given to the ox are watery, and of inferior quality: the price put upon them is therefore amply sufficient.

If the fattening continue for sixteen weeks, an ox will gain 224 lbs. of meat and fat, and increase in value by 18 rix-dollars. If this ox be fattened upon hay alone, he will consume 4,480 lbs.; if with potatoes, he will require 1,120 lbs. of hay, and 67 scheffels 20 lbs. of potatoes.

If the fattening continue for twenty weeks, the ox will gain 280 lbs. of flesh and fat, and his value will be increased by 88 rix-dollars 8 groschen. His consumption during the whole time will be 5,600 lbs. of hay, if he be fed on hay alone; or 84 scheffels of potatoes and 1,400 lbs. of hay, if potatoes be also given to him.

I say nothing in this place of other kinds of succulent fodder, such as cabbages, turnips, mangold wurzel, and carrots. These plants, though common in England, are but rarely used for fattening cattle in this country. Cattle are never fattened in England on mangold-wurzel; and notwithstanding the utility of this plant to milch-cows, I doubt whether an ox could bear it long enough in the quantity which would be necessary if he were fattened on it alone. I observed, last autumn, that cows fed upon this vegetable, without any addition excepting an abundance of straw, were attacked with indigestion, and ultimately refused it. The large quantity of saccharine matter which beet contains, seems to be advantageous to the animal body in certain states only;* but when united with the more farinaceous potato, it is wholesome.

* I have observed the same thing to happen with sheep subjected to the trial. At first they ate the mangold-wurzel with the greatest avidity, and to such an excess that they were attacked with indigestion and ultimately refused the food. I then put another lot on half-dry fodder and half mangold-wurzel, and they certainly fattened more than any of the rest. On my establishment oxen have been successfully fattened on 26 lbs. (18 oz. each) of aftergrass and 50 lbs. of mangold-wurzel per day. As a fattening diet, I consider beet of higher value than our author here assigns to it.—French Trans.

Its value, relatively to that of other produce, is that which I have assigned to it in Vol. I.

In this country, raw potatoes intended for cattle are cut into slices with the root-cutting machine. I am not acquainted from personal observation with any case in which cattle have been fattened on potatoes, either boiled or steamed, though in many brandy distilleries there are arrangements for preparing them in the last-mentioned way, and they are used for fattening pigs. I cannot therefore decide upon the comparative advantages of boiling. If the cattle are fed with 10 lbs. of hay per day, in addition to the potatoes, and are likewise supplied with good straw, or if the hay and straw be cut up together, there will be no danger of hurtful diarrhœa; but when they are fed on potatoes alone, I think that diarrhœa is to be apprehended, and consequently that it is better to boil the potatoes.

As matters are arranged in this country, it can rarely be advantageous in an economical point of view to fatten cattle with grain, or other farinaceous food—such for example as linseed, although it greatly accelerates the fattening: but grain may be used with advantage as an extra diet, and to complete the fattening of very large beasts. The addition of a metzen of ground barley doubtless also expedites the fattening, and may be advantageous in this respect. With regard to other kinds of fodder, especially those which remain succulent, we must not at first venture to give the cattle the full allowance ultimately intended for them; they must be gradually accustomed to it, or they will be liable to indigestion: this precaution is the more necessary in proportion as the cattle are leaner when first stalled. But the most experienced feeders in England say that it is necessary to begin with the most substantial kinds of food, in order to enlarge the secreting vessels, or rather to stimulate and bring them to a higher degree of activity. This is effected chiefly by means of farinaceous and easily digested food; a mash of this description is very useful for the first week or fortnight, during which time a smaller quantity of other food is given. Afterwards, when the cattle have attained a certain degree of fatness, they become gradually less inclined to eat, and do not consume so much as before: they therefore continue in the same state. If it be desired to raise them to a higher condition, their food must be changed to something of a more succulent character, containing a larger quantity of nutriment under a smaller bulk; and if very fat meat be required, grain will often be found advantageous.

Oil cake, especially that made from linseed, may also be profitably used in fattening cattle: it may either be ground and spread upon the fodder, or mixed up in the mash.

When a single beast continues sensibly behind the rest, it will not be advantageous to force him into condition. The attainment of this object might doubtless be effected in some instances by the use of very substantial and easily digested fodder. But the profit would rarely pay the expense, and, therefore, it is better to get rid of the animal as soon as possible, and at any price.

Horned cattle fatten most readily at the age of 7 or 8 years. Younger animals not arrived at their full growth may indeed grow very fat, and furnish delicate and savoury meat: but they always require more fodder and longer time. Old beasts do not fatten so easily: if, however, their organs of mastication are strong enough to chew the fodder well, their fattening may still be profitable, by reason of the low price at which they may be had: they also thrive very well. Many persons, even in England, are of opinion that cattle fatten better the more they have been previously worked: it is certain also that they are then obtained at a cheaper rate. According to these persons, when animals thus exhausted and reduced in condition by excessive labour are fed more abundantly, they acquire new flesh of more delicate fibre, and more succulent, even if already somewhat advanced in age: their fattening must, however, be carried to perfection.

A castrated bull should not be put up to fatten till he has lost all his bull flesh, either at the plough, or other labour. He must, therefore, be worked constantly for two years. His flesh will then be as good and succulent as that of an ox castrated while young.

Castrated cows are rarely seen in this country. When, however, such cows are made to work like oxen, they are particularly well-adapted for fattening, and furnish meat as delicate as that of any other kind of cattle. Where skilful operators are to be found, the castration of young cows is considered quite as safe as that of bull-calves. Instances are known of this operation having been performed with perfect success, even at the age of three years. Among the heifers brought to us from the principality of Oldenburg, we occasionally find some that are castrated.

Whoever would pursue the fattening of cattle continuously, will do well to dispose of them habitually to an honest and experienced cattle-dealer at such a price as to allow him a reasonable profit. For when the dealer becomes familiar with the manner in which cattle are fattened on a particular farm and the meat produced upon it gets into favour with retailers or their customers, he will not fail to avail himself of the cattle of that establishment, and even though the cultivator may occasionally obtain a higher price by taking his own beasts to market, he will probably, in other cases, find himself embarrassed by so doing. As these dealers are well acquainted with the trade, and know at what time and under what circumstances cattle of a particular degree of fatness are most in request at certain places, the cultivator may often profit by following their directions in the arrangement of his system of fattening, the time for stalling his cattle, and the rapidity with which the most esteemed degree of fatness is to be produced.

An enormous amount of fat, artificially produced, and increasing the weight of the cattle to one-third more than the ordinary standard, can be advantageous in particular cases only; when, for instance, a high price is set on that which is uncommon. Every pound of flesh which a beast acquires beyond the usual weight costs perhaps a third more than when the animals are raised only to the degree of fatness common to their breed. The price obtained for it should therefore be proportionably high. This, however, cannot be depended on, unless a certain degree of luxury has been induced in the choice of provisions.

The necessary qualities and training of draught-oxen have been treated of in the first volume of this work, and the cost of their maintenance.

It is not improbable that the use of cows for cultivating land may be established and generally diffused: such a practice would greatly increase their profit. See *Neue Annalen*, bd. iii., st. 1, s. 181, and the following.

SWINE.

In all rural establishments, both great and small, the keeping of pigs is almost indispensable, because the various kinds of refuse of the dairy, kitchen, and garden can scarcely be used in any other manner. This part of the management must, however, be carefully distinguished from the *breeding of swine* properly so called. It is impossible to pronounce, in general terms, on the advantages or disadvantages of this last-mentioned branch; the circumstances under which it will be profitable or not must be carefully considered in each particular case.

If all things be properly taken into account, it will be found that the rearing of swine is rarely advantageous in localities where they must be fed during winter on good grain, and there is not a sufficient supply of pasturage or green food for them in summer. Small profit also will be realized by breeding them in places to which they are brought in large numbers from less cultivated countries, and therefore at a lower price. Equally small will be the profit in the neighbourhood of large towns, where not only the milk as it comes from the cows, but likewise the refuse of the dairy, the potatoes, and other fallow crops, can be readily and advantageously turned into money.

On the other hand, the rearing of swine is profitable where potatoes and turnips are grown in large quantities for feeding cattle, where there is a considerable quantity of bad and light grain among the corn, or where the pastures are damp and marshy and unfit for sheep. This branch of economy will also be found advantageous in rural establishments containing large dairies the refuse of which cannot be more profitably employed, or extensive breweries and distilleries, particularly when there is no abundant supply of low-priced pigs from other countries, and consequently those which are reared may be easily disposed of, either fat or lean. Or again, where there is a good trade in salt meat, and facility of exporting bacon or hams.

There is, perhaps, no branch of economy the profits of which vary so much from year to year as the rearing of swine, particularly in certain countries. The price of pigs is often reduced by one half, or doubled, in the course of two years, on account of the rapidity with which these animals increase and diminish in numbers. When a high price leads to increased production, and the value of grain subsequently rises, the markets become glutted with swine, because every one endeavours to get rid of his surplus stock. The owners begin to find out that the grain required for feeding their pigs will scarcely be repaid by the sale of them, and consequently they endeavour to get rid of the young ones. A year after, the number of pigs becomes considerably reduced in all the rural establishments of the country, and the market-price consequently rises. Every one then becomes anxious to keep pigs for his own domestic use, and each consumer endeavours to outbid his neighbour, so that frequently, by the next year, the price rises enormously high. I have seen pigs which, two years before, would scarcely fetch three rix-dollars, sold for ten or twelve, without having cost much to the breeder. This is one of the cases in which a cultivator may easily be alarmed by a rise or fall of price, and allow himself to be guided by general opinion without examining its foundation. He may thus be induced to take false steps, and diminish instead of increasing the number of his pigs, without considering that since the greater number of breeders are diminishing theirs, his own would, in two years' time, be likely to yield a large profit. When, on the other hand, the generality of cultivators are tempted by a high price, which, contrary to all experience, they imagine must always continue, to increase the number of their pigs, the more prudent breeder will see in this very circumstance a motive for diminishing his stock, without, however, completely giving up this branch of economy.

The breeds of swine best known in the north of Germany, but nevertheless crossed in various ways, are the following :—

(*a*). Moldavian, Walachian, and Bothnian pigs; distinguished by great size, dark grey colour, and very large ears.

(*b*). Polish, or, more properly speaking, Podolian pigs; also very large, but of a yellowish colour, and having a broad brown stripe along the spine.

These two races furnish very large pigs for fattening, but they require a proportionably large quantity of food; besides, they are not very productive; the sows seldom have more than three, four, or five young ones at a birth.

(*c*). Bavarian pigs, usually marked with reddish-brown spots. They are much esteemed for the smallness of their bone, and the facility with which they fatten, but their flesh is considered too soft.

(*d*). Westphalian pigs, of considerable size and very productive; they bring forth ten or twelve at a time.

(*e*). The so-called English pigs. I do not know whether they really come from England, but the English certainly pay great attention to the management of swine, and possess many different breeds. These pigs have longer and deeper bodies than the Westphalia variety, but they require pasturage and food in general of a very substantial quality.

The crossing of these two last-mentioned races is considered advantageous.

(*f*). The common German pig. This breed differs in its characters in different provinces, and is of various colours, white, grey, black, and spotted. It does not attain the size of the preceding, but may be supported on a smaller quantity of nourishment, and is more easily fattened. This race might doubtless be improved within itself by the use of better nourishment, and the prevention of breeding till a later period. But those who undertake the management of pigs on a larger scale than usual, generally seek to obtain another breed, at least for the sake of crossing it with the native race.

(*g*). The black, fine-haired, African pig has lately been brought to this country from Spain, together with a flock of merinos, by Baron Vincke, who has introduced them upon his estates at Friedland. This variety does not grow so large as those already mentioned, and is scarcely adapted for fattening, but grows rapidly and keeps up its condition even when poorly fed. It is therefore very valuable, both as a porker and for its hams. The crossing of this breed with one of larger size has produced a medium variety, which, as far as observation has hitherto gone, appears to be excellent in every respect.

(*h*). The Chinese pig, much esteemed in England, and introduced, some time ago, into this country. It is distinguished by a very hollow back, a belly reaching nearly to the ground, quietness of disposition, and by not turning up the ground much. It does not attain a very great size, but grows fast, and is much esteemed in England as a porker.

The male pig is called a *boar;* the female a *sow;* the young one, while it feeds on its mother's milk, a *sucking-pig*.

The Germans also make use of various words for denoting the age of pigs, but there are no corresponding terms in other languages.

In the breeding of swine, as much as in that of any other live-stock, it is important to pay great attention, not only to the race, but also to the choice of individuals. The sow should produce a great number of young ones, and she must be well fed to enable her to support them. Some sows bring forth ten, twelve, or even fifteen pigs at a birth, but eight or nine is the usual number, and sows which produce fewer than this must be rejected. It is, however, probable that fecundity depends also on the boar; he should therefore be chosen from a race which multiplies quickly.

Good one-year bacon-hogs being much in request, we must do all we can to obtain a breed well adapted for producing them. Swine of such a breed may be known by their long bodies, low bellies, and short legs. Long pendulous ears are usually coupled with these qualities, and attract purchasers. If, however, as is often advisable in large dairies and cheese-factories, hogs are to be sold at all seasons to the butchers, greater attention must be paid to quickness of growth and facility of gaining flesh, so that the animals may attain their full growth and be ready for killing before they are a year old. This quality is particularly prominent in the Chinese and African breeds, but among our ordinary varieties, hogs are often met with which are better adapted for this purpose than for producing large quantities of bacon and lard.

The boar should be selected from a race well suited to these several purposes; he must be sound and free from hereditary blemishes. He should be kept separate till he is about a year old, and has finished his growth, otherwise he will begin to leap very early. He is usually castrated before completing his third year, otherwise his flesh becomes uneatable. If, however, he is of a peculiarly excellent breed, which cannot be replaced, his flesh may be sacrificed for the sake of preserving him for breeding a few years longer.

A boar left on the pasture, and at liberty, with the sows, might suffice for thirty or forty of them: but as he is usually shut up, and allowed to leap at stated times only, so that the young ones may be born nearly at the same time, it is usual to keep one boar for ten or twelve sows. Full-grown boars being often savage, and difficult to tame, and attacking men and animals, they must be deprived of their tusks.

The sow must be chosen from a race of proper size and shape, sound and free from blemishes and defects. She should have at least twelve teats; for it is observed, that each pig selects a teat for himself, and keeps to it, so that a pig not having one belonging to him would be starved. A good sow should produce a great number of pigs, all of equal vigour. She must be very careful of them, and not crush them by her weight; above all, she must not be addicted to eating the after-birth, and what may often follow, her own young ones. If a sow is tainted with these bad habits, or if she has difficult labours, or brings forth dead pigs, she must be castrated forthwith. It is therefore proper to bring up several young sows at once, so as to keep those only which are free from defects. Sows and boars must not be raised from defective animals.

Sows are almost always in heat till they have received the boar: they get into this state even at the age of four or five months; but they are commonly not put to the boar before the end of their first year, It is indeed often deferred for two years, when it is desired to raise a large breed from one of middling size.

Sows are sometimes required to produce only one, sometimes two litters in a year. When highly fed, they may be covered three times in thirteen months; but this is rarely advisable. If two litters be wanted in the year, as is usually the case in establishments where this branch of economy is pursued on a large scale, and there is a sufficiency of nourishment for the purpose, the boar is put to the sow at the beginning of October and the end of March. As the sow goes with young from four months to eighteen weeks (some persons profess to have met with examples of sows going for twenty, or even twenty-one weeks, and to have remarked, that old sows carry longer than young ones), she brings forth in March and August. But if she is to produce only one litter, she should litter in April, and the pigs be reared on pasturage. The arrangements to be made with relation to this matter will be determined by the various objects contemplated, and the general circumstances of the establishment. Sucking-pigs born in August or the beginning of March require good winter-feeding. When the only object in rearing swine is to turn the pasturage to account, and then sell the young pigs, it may be preferable to have but one litter, in April. Badly arranged, cold sties may also afford a reason for not having more than one litter produced in a year. But when the management of swine is well arranged, and winter-food abundant, it is always advantageous to have two litters in the year.

Well constructed buildings are perhaps of greater importance in the economy of swine than in that of any other kind of live-stock. Success, indeed, is mainly dependent on attention to this point, all other care being useless without it. The pigs should be separated according to age, sex, and condition: a particular space, or stye, is therefore required for each of the following descriptions of animals:

(*a*). For pigs just weaned;

(*b*). For young pigs, which might otherwise be wounded or hunted by the larger ones;

(*c*). For full-grown pigs, comprising the castrated of both sexes, sows which are being reared, and those which have farrowed and had their young ones weaned;

(*d*). Small sties for each sow suckling her young;

(*e*). Fattening-sties;

(*f*). Sties for the boars.

In the construction of these habitations, care must be taken that the animals are warmly housed, and the sties at the same time well aired, and clean; for though swine will roll in the mire to refresh themselves, a clean sty is nevertheless of primary importance to them: the piggery must also be provided with every convenience for winter-feeding; and if the food is to be chiefly derived from a dairy, brewery, or distillery, the piggery should communicate with this building. It should be exposed to the sun, and, if possible, surrounded with a yard, in which the pigs may be allowed to go out in separate divisions. Lastly, care must be taken to preserve the dung and urine, so that no manure may be lost.

For the rest, the construction of piggeries belongs to rural architecture.*

The sow during her pregnancy must be well fed, not to excess, but in the same manner as a fattening hog, for she will otherwise be liable to miscarry. Above all, she must not be allowed to suffer from hunger when her delivery is approaching, for such a circumstance might induce her to eat the after-birth and her young ones. It is well to be acquainted with the day when conception has taken place, because the time of delivery may then be calculated beforehand, and the necessary precautions taken. The sow must then be carefully watched: when she is likely to farrow in the night, the swineherd, or the female servant who looks after the pigs, should sit up with her. It is always best to give a separate sty to each sow; or at most, to leave together only two which are accustomed to one another; otherwise the young ones will be in danger of being crushed.

The sow must be supplied with good litter; but not in very great quantity, for the pigs might bury themselves in it, and be crushed to death, without any fault on the part of the mother.† The young ones, as they are born, must be taken away, and collected together, until the delivery is over, and the after-birth has come away; this precaution is necessary, to obviate the risk of their being crushed by the mother by creeping under her belly, while she is suffering the pains of labour.

A quarter of an hour after delivery, or even while the sow is ridding herself of the after-birth, the swineherd endeavours, by gently scratching her belly and teats, to induce her to lie down, and then he puts the young ones near her. It has been observed that each sucking pig has its own peculiar teat, and does not willingly go to another; and likewise, that the fore teats almost always yield more milk than the hinder ones, for the pigs which

* A description of this branch of architecture will be found in Gilly—"Anweisung zur landwirthschaftlichen Baukunst Herausyeeben von Friederici," Bd. i. Abth. 2, s. 12, u. f. A.

† For this reason, the straw put under the sow should be more or less cut.—French Trans.

suck at the former become larger than the rest. The smallest pigs are therefore put to the fore teats, so that they may attain as great a size as the rest.

When several sows farrow at once, and one of them has but a small number of pigs, she may be made to suckle some of the young ones belonging to those which have produced too many. They must, however, be put to her before she gets up, that she may not be aware of it. The number of young ones often exceeds that of the teats: in such a case, if recourse cannot be had to the method just spoken of, the smallest pigs must be killed, that they may be eaten as sucking pigs by those who like that dish.

Sows, at their first farrowing, usually produce but few young ones; a sow which brings forth a great number the first time is highly valued. An old sow which brings forth fewer than eight pigs at a birth is not worth much. Those which have very low bellies, reaching almost to the ground, usually produce but few pigs in comparison with the number which might be expected from them.

As soon as the sow has farrowed, water containing ground barley is given to her: she must be well fed while suckling, that she may give plenty of milk. She may be fed upon sour milk and ground barley, bran, and oil-cakes well soaked in water: all extraordinary diet likely to bring on diarrhœa, either in the mother or the young ones, must be avoided. Good dry litter must be given to her, and often changed; the quantity, however, must not be very great, for fear of the young ones hiding themselves in it.

Young pigs are often castrated at the age of two-and-a-half or three weeks; but they then grow up weaker, smaller, and higher on the legs, than those upon which the operation is not performed till they are six months old. It is, however, less dangerous when performed early; if it be deferred, the males and females must be separated, both in the sty and on the pasture, till they have been subjected to it.

Cruel mistakes are often committed in castrating: these must be carefully guarded against, especially in places where the castrators of pigs are licensed. Animals of both sexes are sometimes imperfectly castrated: the effect of this treatment is certainly to unfit them for breeding; but they nevertheless retain the desire of copulation, and not only become heated themselves, but derange the whole herd.

When pigs are to be castrated, they should for four and twenty hours previously be supplied with food in moderate quantity, and such as will not swell in the stomach. Great care must be taken in choosing the animals to be retained for breeding.

The pigs, after castration, must be left quiet, and fed on clear wash, made of linseed-cake and sour milk, till they get well.

It is not difficult to wean pigs, because they begin to eat as soon as they are a fortnight old. Separate troughs, lower and shallower than the rest, are provided for the young pigs, unless they are intended to eat out of the same trough with the old ones.

Each sty should have a separate egress into the pig yard, so that the old and young pigs may easily be let out, and supplied with fresh water.

When the young ones have sucked for four weeks, the sow is let out without them, and they without the sow alternately, the young pigs, however, only in fine weather; in this manner they get accustomed to dispense with one another's society. The mother is also scantily fed, that her milk may diminish, and she may repulse her young ones.

Finally, the pigs are fed with a little barley, to accustom them to hard food, and sharpen their teeth, as it is said.

Weaned pigs are at first supplied with five meals per day; when they have attained the age of six weeks this number is reduced to four; after nine weeks they are fed but three times per day like other pigs.

They are easily accustomed to take their food cold; this is for the most part advantageous, as warm food might injure them. When they do not eat all the food in their trough, the remainder must be taken away and the trough well cleaned. A fresh supply must then be given to them, but in smaller quantity.

Sour milk is undoubtedly the best and most wholesome nourishment for young pigs. When there is no market for cheese, the most profitable mode of disposing of the skimmed milk is often to give it to these animals. A pig eighteen weeks old fed on a sufficient quantity of sour milk, will be larger than one a year old fed in a different manner.

After having attained the age of nine weeks, the young pigs must be accustomed to the same food as the old ones, without however being left in the same sty with them. If they have not been castrated while sucking, the sexes must be separated till that operation has been performed. The weakest of the young pigs must, if possible, be kept apart, for the others bite and keep them from their food, and thus their growth is stopped.

In summer swine are fed either on pasturage or in the sty.

In well cultivated countries it will rarely be advantageous to have grass land fed off by pigs; but in localities where there are hollows covered with sour grasses, marshy spots, cold, and covered with bushes, and a great many ponds; or where snails are numerous, and the ground contains a large number of worms and roots which are agreeable to these animals, there is no better mode of turning the pasturage to account. Success is, however, mainly dependent on the employment of a good swine-herd, who will take care to select a proper spot for the animals at each moment of the day, and for every change of temperature. At noon they must be sheltered from the sun, and taken home, if no shelter can be found in the fields. The first pasturage on the stubble cannot be consumed in any manner more advantageously than by pigs, because they avail themselves of the seed which has fallen on the ground. Moreover, they crop the plants which they find, and tear up roots not easily destroyed by the plough—the *sium falcaria*, for example, which cannot well be destroyed by any other means. They almost clear the soil of insects, worms, and mice. Where root-crops are cultivated, they also find abundant nourishment on the field after the crop has been taken: there is no better way of disposing of the residue.

But when pasturage is scanty, they always require a little additional food at night and morning.

In establishments possessing large dairies, swine are house-fed during summer. This method affords a means of disposing of the sour milk, as well as of kitchen and garden refuse, tailing corn, and similar matters, which for this purpose are mixed, and allowed to turn slightly sour. But the best nourishment for house-fed pigs in summer consists of green lucerne given to them just as it is mown, or chopped and mixed with whey, or slightly sour milk. But pigs thus fed must have the range of a spacious yard, in which they can find clean water, or they must be taken to a place where water is at hand for them to drink and bathe in.

The feeding of pigs in winter may be found advantageous either in breweries, distilleries, and large dairies, or where root-crops are cultivated in large quantities. In large dairies the greatest deficiency of food usually occurs at the beginning of winter. The pigs may then be fed on sour milk mixed with water; and supplementary food may be found in kitchen refuse, bran, mill-dust, siftings, and the seeds of weeds which have been separated from the corn: these are given to the pigs either ground or soaked in warm water. If cows begin to calve at a time when scarcely any cheese is made, a portion of the milk may be disposed of in this manner. Moreover, when fallow crops are cultivated, there can be no deficiency of winter food, particularly when advantage is taken of the several kinds of refuse just mentioned.

Good grain is usually too dear to be given to pigs. These animals must, however, be well fed, or they will yield no return. By good feeding a first year's pig may be raised to the value of one which is two years old;

and we have only to consider farther, whether it is advantageous to give in one year the quantity of food which would suffice for two.

In arranging his system for the breeding and fattening of pigs, the cultivator should determine beforehand what breed he can most easily dispose of in his own country, and what market he will be likely to find for each variety. The following kinds may be disposed of:—

(*a*). Weaned pigs, in countries where there are a great many small cultivators and gardeners who keep a cow, and can send their pigs to grass.

(*b*). After harvest pigs, which have attained half their growth, or are less than a year old, may be sold to persons who fatten a pair of these animals for their own use, and prefer those of middling size, because they are cheaper.

(*c*). Full-grown pigs, either to brewers and brandy distillers in towns, or to establishments which have a large quantity of refuse, or can procure it in their own neighbourhood; or generally to all those who do not concern themselves with the breeding of swine, but yet possess the means of fattening them.

(*d*). Half-fattened pigs, to pork-butchers at all seasons.

(*e*). Pigs completely fattened to household establishments, both in town and country, at Christmas.

In farming establishments for the breeding and fattening of swine, great additional security is obtained by determining beforehand which of the five preceding classes, and how many of each class, are to be maintained and sold. These pigs must then be sold at the price which they will fetch. By keeping the young ones longer than is consistent with the system of the establishment because we are dissatisfied with the price offered to us, we shall most likely be embarrassed for want of food, and ultimately obliged to sell them at a still lower rate. Indeed, farmers, after keeping their pigs for a long time under these circumstances, have often been compelled to send them to market. It is doubtless unpleasant, after having obtained the price of three rix-dollars for weaned pigs in one year, to be obliged to sell them for eight groschen in the next, a circumstance which I have known to occur several times; but we must, nevertheless, make up our minds to the loss, if the general plan of our establishment require it.

When sucking pigs are not sold, matters are usually arranged so that the young ones born in spring may be kept either for breeding or for fattening in the following autumn; and those born in April, to be sold for fattening when they are a year old.

Full-grown pigs are the best adapted for fattening. A pig of good breed, and well fed, may reach his full growth in a year. But, generally speaking, they do not arrive at this stage till two or even three years old. It is common in England, though not in this country, to feed pigs in summer on fodder-plants, such as clover, lucerne, tares, buck-wheat, and spurrey. For this purpose, the pigs are either turned into the fields, or fed in the sty or in permanent enclosures. The green-meat just spoken of is cut up like cabbages, and mixed with various kinds of refuse proper for feeding pigs: the whole is then placed in large walled reservoirs, salted, pressed, and left to turn sour. The pigs are fed on it in autumn, and get very fat.

In large dairies milk may be used for feeding pigs, even if they are not bred on the farm. These animals are fed either on sour milk or whey: many farmers are of opinion, that the former may be used for this purpose more profitably than for making cheese. It is certain that pigs fed in this manner soon attain considerable weight, provided that towards the end of the fattening a little ground barley is put into the diluted milk to thicken it. The flesh of these pigs is excellent. But when the fattening has been begun in this manner, it must be continued; for all other kinds of food would diminish instead of increasing the weight of the animals. Ground corn can be used only as a supplementary aliment.

When large quantities of root-crops are raised, they may often be very profitably used for fattening swine. At the present day, potatoes are most commonly used for this purpose; they are usually steamed, mashed, and mixed with water. Pigs will readily eat raw potatoes for a short time, and in moderate quantity; but soon take a dislike to them when fattening. When the fattening is nearly finished, a little ground corn is added to the potatoes to complete it. Some persons think carrots better than potatoes for fattening; pigs willingly eat them raw, and thrive well upon them. The flesh of hogs thus fed is said to be particularly firm.

If pigs are to be fattened entirely on the refuse of the brewery, it must be given to them in very large quantities. They gain flesh rapidly at first, but do not become good bacon-hogs unless supplied with more substantial food towards the end of the fattening. This refuse is of better quality when small-beer is not extracted from it. It must be kept under water to prevent it from heating.

The refuse of the brandy-distillery is more substantial, and better adapted for fattening, than that of the brewhouse. According to *Neuenhahn*, eight Nordhausen scheffels (equal to about six of Berlin), used daily in the still, will supply food for fifty hogs: this author remarks, however, that it is better to keep below than above the full number, the loss occasioned by leaving a portion unconsumed not being nearly so great as that which arises from a deficiency in the supply. At first this refuse must be mixed with water, as the hogs will otherwise refuse it; in fact, it makes them giddy and unable to keep their feet; afterwards, the quantity of the food is gradually increased, till they are completely accustomed to it. Neuenhahn says that the refuse of the brandy-distillery cannot be given to the pigs too warm, or too soon after its removal from the still; and that it never makes them hot; but on the contrary, when allowed to get cold and stale, it is rather injurious than beneficial to them. On the other hand, I have been assured by many experienced distillers who fatten large numbers of hogs, that it requires great attention, and the employment of a man on whose care we can rely, to prevent the refuse being given to the animals while too warm, for it then injures and retards them to a great extent. It must be given sometimes thick, sometimes thinned with water, in order to keep up the appetite of the animals.

The residue of the manufacture of starch, the products of the various washings which this preparation involves, and the refuse of wheat, are far superior to brewers' and distillers' refuse. Hogs fed upon these articles fatten more quickly, produce firmer flesh, more substantial bacon, and a greater quantity of lard. At first the animals eat these matters with great avidity, and often to excess; in that case, they refuse them after a time. The quantity must therefore be carefully regulated, and the troughs kept very clean. If this mode of feeding be used alternately with one of a different nature, the fattening will be effected with greater certainty. The quantity of this refuse collected at once is often greater than can be consumed at the time: it is difficult to preserve, because its animal portions soon putrefy. The only mode of preservation is to dry it, make it into cakes, and bake it.

Corn-feeding cannot be really advantageous, excepting in a limited number of cases. It is, however, frequently resorted to, and in various ways. According to observations of the English, a good hog increases in flesh from 9 to 10 lbs. for every bushel of grain, half barley, half peas, that he eats; or from 14 to 15 lbs. per Berlin-scheffel; hence we may calculate how far corn-fattening can be profitable. Grain is given to pigs in the following ways:

(*a*). Crude and dry. The animals chew and bruise it very well: but they must be well supplied with water. Pigs have sometimes had their stomachs burst after eating to excess of this food; it must therefore be given with great caution.

(*b*). Grain soaked in water cannot well be injurious; but it has been often remarked, that swine will not eat much of this food. If it can be dried again, after germinating, or made into malt, it will be improved. It may also be left to turn sour, and will then be more useful and agreeable to the animals.

(*c*). Grain burst, by boiling, is particularly useful for fattening: this method saves the expense which would otherwise be requisite for grinding the corn: it will not, however, effect any saving, unless fuel be cheaper.

(*d*). Ground corn is, however, the best and most trustworthy food. Swine are rarely cloyed with it when properly given to them. It should be soaked in water some time before, then mixed with a larger quantity of water, and well mashed, so that none of it may remain in lumps, for that would probably bring on indigestion and other disorders. The corn should not be soaked in boiling, but in tepid or cold water. When pigs are fed on ground corn, it is usual to give them towards evening a little grain in its natural state; this is said to keep up their appetite.

Of grain, properly so called, barley is by most persons considered as the most advantageous for swine; others prefer oats; but pulse, such as peas, tares, and beans, are much more efficacious; only when pigs are to be fattened on them, they must not previously be fed ground barley alone, for they will then refuse the pulse. If the latter are to be afterwards given alone, small quantities of them must from the beginning be mixed with the barley; but pigs not yet accustomed to barley willingly eat pulse, whether hard, soaked, boiled, or ground. According to experiments made in England, pulse, especially peas, fatten much more easily, and are more agreeable to swine when slightly sour.

In general, fattening with sour dough is commonly extolled as cheaper and quicker than that produced by grain. Ground corn, or coarse meal, is mixed with warm water in a pail, and made into a paste; yeast is then added, and the whole kept at a somewhat high temperature: in twelve hours it becomes sour. A portion of this sour dough is then mixed with water, to form a thick mash for the pigs. When the dough is nearly finished, a fresh portion of meal or ground corn is added to the remainder. This mash, made of sour dough, is much relished by the pigs; it is likewise wholesome and refreshing to them. But when given alone, it serves only to fill them up: it causes them to gain rapidly in flesh; but the meat is light and flabby, and the quantity of lard and bacon small. It is better, therefore, to add to it every day a quantity of unground grain, especially peas.

Some persons profess to have been wonderfully successful in fattening their pigs on bread. The bread for this purpose is made of coarse barley or rye flour; it is cut into pieces, dried in the oven, then soaked in water, and given in the form of a thick mash. When soaked in sour milk or whey instead of water, it is said to surpass all other kinds of food in the quickness and efficacy with which it fattens.

I consider maize as superior to all other kinds of grain for fattening. It produces very solid flesh, and gives firmness to the bacon. Swine are very fond of it. With us it is seldom used excepting to complete the fattening, each pig being supplied night and morning with a handful or so of maize-seed: the quantity of fat is thereby greatly increased. Whole ears of maize may, however, be thrown to the pigs: they know very well how to extract the seed. This practice is very general in Hungary, where large numbers of Moldavian pigs are thus brought to the highest state of fatness, and afterwards sold in Vienna.

In fattening pigs, the following rules must also be observed:

These animals are more inclined than any others to over-eat themselves, and then they are much retarded. Hence, it is always better, if one extreme must be incurred, to give them too little than too much. If they are attacked with indigestion, they must be kept without food for four-and-twenty hours, and then a few handfuls of unground corn with a little salt must be given to them six hours before resuming the ordinary food.

Swine eat a great deal when first put to fatten, but much less when fat. The most nutritious and substantial food is therefore commonly reserved for the end of the process. Many farmers, however, particularly in

England, think that these animals should at first be supplied with very substantial food in order to increase their vital energies, then with a larger quantity of some less nutritious kind of aliment, and, finally, with that in which the nutritive power is most concentrated.

It has generally been found useful to give pigs, from time to time, half an ounce of pounded antimony, either upon their solid food or in sour milk. This medicine not only maintains their appetite and facilitates digestion, but also preserves them from leprosy. It may be given every week or fortnight, especially when the pigs appear dull and lose their appetite.

The space in which pigs are shut up should be rather small: they will be more quiet and peaceable in consequence. If, however, there should be among them one that is weak, sickly, and illtreated by the rest, he must be immediately removed from them, or they will kill him. When pigs are hungry, they are apt to bite one another; but when well fed, they are quiet enough. It is best, however, to divide the troughs into separate portions, placing before each a board with notches in it just large enough for a pig to put his head through.

The strictest regularity should also be observed in the hours of feeding.

It is of great importance to keep pigs as clean as possible, and give them dry litter. Bathing twice a week accelerates their fattening and makes them more quiet.

It only remains to speak of fattening in the woods. Swine thus fed never attain the highest degree of fatness; acorns, however, make their flesh and bacon very firm; beech-mast, on the contrary, produces flabby muscle and unsound fat, which runs when heated.

Swine should be kept in the woods day and night, and be provided with proper covering or shelter. If brought home at night, or at liberty to return, they get heated and lose all that they have gained in the day. Fattening in the woods is doubtless the cheapest of all methods, but there is not always a sufficient quantity of food. If the pigs do not quickly arrive at a certain degree of fatness, they derive but small advantage from this mode of feeding, for want of rest and warmth.

When pigs are accustomed to pasturage, that of the woods is always preferred by them. It is indispensable, however, that they have a proper supply of water.

SHEEP.

The management of sheep has sometimes been too much decried, sometimes too much extolled, in comparison with that of other domestic animals. Leaving out of consideration those peculiarities of situation which must always affect the profit to be derived from one species or the other, it will be found that their profit has always been in a great measure determined by circumstances, and the mercantile circumstances resulting from them. Farther, it is undeniable that the particular care and attention devoted to one kind of live-stock or another, have also greatly contributed to the profit derived from it. It is generally acknowledged that cattle of any kind, when well fed and looked after, repay much more fully the judicious outlay incurred for their maintenance, than ill-kept animals repay the niggardly expenditure which the owner is obliged to bestow upon them. Profit is derived only from the excess above that which is absolutely necessary; the quantity of nourishment which just keeps an animal alive, is, to a certain extent, lost. It is for this reason that the flocks of sheep, formerly so badly fed, yielded no profit; and that, in the opinion of most farmers, fodder and pasturage, notwithstanding their trifling value, were absolutely lost upon these animals, which consequently owed their preservation to nothing but the urgent demand for the manure obtained by folding them on the land. But when attention was aroused to the profit yielded by improved sheep, and greater care and better food were bestowed upon them, larger returns were soon obtained, while, at the same time, the breed was improved. The profit derived from sheep then became so great, that they were soon more highly prized than horned cattle and the dairy, which, in fact, were decried. Unfortunately, there were but few rural establishments capable of properly maintaining these two kinds of live-stock at once; so that one was sure to suffer by the preference given to the other, and the breed declined more and more.

Commercial circumstances, which themselves depend on politics, have for some years favoured the rearing of sheep, by raising considerably the price of wool. Hence, throughout almost all Europe, animals of this kind are more highly prized by farmers than horned cattle; and though this high estimation has been excited by the merino breed alone, it nevertheless exerts more or less influence on the ordinary races, and causes them to rise in price.

It is almost universally admitted that ten sheep cost as much as one cow, whether pastured or stall-fed. This proportion was originally based on the kinds of sheep and cows maintained in the north of Germany, both of which were in the most miserable state. The same proportion seems, however, to hold good when both races are improved together, for good sheep as well as good cows require twice as much food as bad ones, whether at pasturage or in the stall. Even if the quantity of food consumed by sheep does increase with the improvement of the breed at the same rate as with cows, the proportion is nevertheless kept up by accessory expenses and additional risk.

If, then, in localities where these two species of live-stock can be equally well maintained, it be asked, "Which kind ought the farmer to increase or diminish, to the detriment of the one or the advantage of the other?" the question will usually be answered by the reply given to the following: "Which will yield the greater profit, ten sheep or one cow?" This question cannot be answered in general terms, but is easily resolved in each particular case, even by a very superficial calculation. Among other considerations, temporary occurrences have at the present day considerable influence on this matter; their indications must, undoubtedly, be attended to, though not to such an extent as to preclude the possibility of altering the proportions between our several kinds of live-stock according to the manner which circumstances may render advisable.

The proportion which for the last ten years has subsisted between the price of meat and butter on the one hand, and that of wool on the other, though both have been very high, has decidedly given the advantage to the sheep over the dairy, when both sheep and horned cattle have been fed upon pastures equally well adapted to either. But this is not the case when cows are stall-fed, for this mode of feeding saves so large an extent of ground, which must otherwise be used for pasturage, that the equality in the net produce of the soil is re-established by it. But though stall-feeding, which is much better adapted for horned cattle than for sheep, should even strike the balance in favour of the former, it would still not follow that, under existing circumstances, the number of sheep should be diminished; on the contrary, it ought rather to be increased, because the stall-feeding of horned cattle saves a quantity of pasturage which cannot be turned to account in any other manner.

An acquaintance with the various and beautiful breeds of sheep to be found in various parts of the world is an interesting subject of natural history, but does not belong to the science of agriculture. I shall not, therefore, speak of the races met with in distant parts of Europe. The several breeds peculiar to Great Britain are mentioned in my "English Agriculture." On this matter the reader may also consult Culley's "Observations on Live Stock, containing Hints for choosing and improving the best Breeds of the most useful kinds of domestic Animals." London. 1786. 8vo.

I shall here content myself with speaking of those which are found in Germany, whether established there from the remotest times or lately introduced.

There are four principal varieties, viz.:—

(*a*). The sheep of the *landes* or heaths.

(*b*). The breed of the marches or low countries.

(*c*). The ordinary native breed.

(*d*). The merinos.

The *sheep of the landes* are small; they are scarcely found anywhere excepting on the landes of Luneburg and Bremen. They would not be profitable in other countries; indeed, they would scarcely be able to live elsewhere, for they feed almost wholly on furze, and soon become excessively fat, and lose their health when put upon richer pasturage. All sheep of this breed have horns: they are seldom quite white, but grey, brown, or black. Their wool is generally coarse and harsh to the touch; some, however, have finer wool, and others, among their long coarse wool, have also a short fine sort, which however is difficult to separate. They are usually shorn twice in the year: first, towards St. John's-day, when a ram will give from 2lbs. to 3lbs. of wool, a wether from 2lbs. to 2½lbs., and a ewe from 1lb. to 1½lb.; and secondly, about Michaelmas: at this time, however, they are not shorn so close to the body, and the quantity of wool obtained is scarcely a third of that cut off at the first shearing. This wool, especially the short kind, is used in the manufacture of common hats: coarse stuffs are also made of it, particularly a tissue of wool and other articles mixed together. Frequently also there is a large demand for it in foreign countries, for the manufacture of sailors' coats and cloth list.

Sheep of this breed yield a very small return; but in their native countries they cost scarcely anything, living almost wholly on furze both in winter and summer. They scratch away the snow to get at this plant, and when it is too deep to enable them to do this, the snow-plough is used to clear a passage for them to obtain their food. Dry furze is also given to them in the stall or under sheds where it is usually spread out for them, together with a little horse-dung. If a little buck-wheat straw be given to them from time to time, it is only as a relish. Some farmers, however, give a little buckwheat seed to the ewes at lambing time, and a little hay to the lambs. Notwithstanding the hardiness of this race of sheep, they cannot endure passing the night in open pens.

Their weight is very small; a tolerably good wether yields only about 30lbs. of net flesh. Their flesh is rich, of delicate fibre, savoury, and pleasant to the smell.

This race of sheep has been crossed with the ordinary native breed, and has produced an intermediate variety called half-bred: this mixed breed presents no advantage: it requires better feeding both in the stall and at pasturage: without this it will degenerate; and nevertheless it yields very little more than the pure breed of the landes.

The sheep of the marches, or low countries, otherwise called *the Friesland breed*, include several varieties, all of which seem, however, to spring from a common stock, and to have been merely changed by the care and food bestowed upon them, and the choice of individuals for breeding. Those of the most fertile districts are very large and fat; they may be raised to a weight of 120lbs. net flesh, or even more. Their wool is thick, of various degrees of delicacy and softness, never frizzle, but smooth, and fit for combing. They yield on the average 10lbs. of wool when fed on very rich pastures; the smallest, however, give but 6lbs. or 7lbs. This wool is very useful for the manufacture of certain kinds of stuff, especially stockings, whether knit or woven; but it is not good for cloth making.

The ewes of this breed bring forth sometimes two, sometimes three, lambs at a birth; some have been known to produce even more. The variety of smaller size and bone fatten easily; they are fit for killing at the age of two years. They give plenty of milk, which is often drawn from them. I have known ewes of this breed, not even of the larger variety, to yield every day a quart of milk, which was pronounced by judges to be of exellent quality.

These sheep then might be expected to be very profitable: all things considered, however, they are not so in reality; for in proportion to their produce they require very substantial pasturage and feeding. But few of them are therefore maintained, and those only in countries where they can be fed on pastures of which no other use can be made. In lowlands protected by dikes, these animals graze on the dikes and beyond them. When they are to be fattened they are allowed to go amongst the other cattle on fattening pastures, or placed in grass fields which are not fit for other animals, but are used as meadows, and require to be left at rest for a year, and improved by sheep folding. The sheep eat off the old grass, though it may be mixed with rushes; the meadow is greatly improved by this treatment. The animals are seldom attacked with watery cachexia while on the pasture: if they are, they must immediately be sent to the slaughter-house.

Sheep of this breed may be everywhere maintained by good stall-feding on clover: but from various trials which have come to my knowledge, this mode of feeding appears to be too costly in proportion to the return. The only variety of the race which seems to be profitable is a small kind, with very thin bones, fed on very rich and upland pastures. This variety has perhaps been produced by crossing. The others are met with in almost all low countries, and are thought by some persons to have sprung from the ordinary native breed, gradually improved by rich pasturage. To me this opinion appears totally unfounded. I rather think that they came originally from the banks of the Rhine and Elbe, and have thence been transplanted into the countries where they are at present found.

The *ordinary German sheep* exhibit several varieties, but nevertheless appear to have a common origin. The various degrees of attention bestowed on their breeding and maintenance, appear to be the sole cause of the observed differences, which, though now hereditary, would soon change if the animals were otherwise fed. In all parts of Germany where sheep have for some time been treated with care and fed on good pasturage, especially on the mountains, the breed is found to be superior, even in quality of wool, to that of places where they are scantily fed, and treated as mere occasional accessories.

In Lower Saxony there is a particular variety distinguished by the name of the Flemish or Rhine breed. But this variety has preserved its peculiar characteristics in those places only where it has received the very best food and most unremitting attention: where this has not been the case, I do not think that it differs perceptibly from our Pomeranean and Prussian breed. It would be worth while to examine the various gradations of fineness and quality of wool in the several provinces of Germany. For a long time, however, we have concerned ourselves least in the pursuit of the very inquiry most within our reach; and now that the merino breed is introduced among us, the ordinary German races are scarcely thought worthy of closer investigation. The introduction of a German breed of peculiar excellence, and the perfecting of it *within itself*, might however, and probably would, repay the trouble bestowed upon it; and such a breed might, by the weight of its wool, by greater vigour of constitution and facility of fattening, counterbalance the higher value of the merinos. The wool of the country varies infinitely in fineness, elasticity, and thickness. There is a race of German sheep whose wool serves for the manufacture of cloth of average fineness and great durability. There are others, on the contrary, whose wool is so coarse, that it can only be used for stuffs of the most ordinary description. Our sheep likewise differ greatly both in the thickness and quantity of their wool: superior fineness and elasticity are almost always united with great thickness of fleece.

Our native sheep are certainly more capable than the Spanish breed of enduring bad pasture and stall-feeding; they are likewise more robust and exposed to fewer diseases. If, therefore, the general circumstances of a rural establishment are inconsistent with the maintenance of sheep on pasturage and fodder of the quality required for enabling the merino breed to yield a sufficient quantity of wool, the farmers must not be visited with unqualified censure for keeping to the native breed. If, however, it be asked, why the management is not such as to allow the maintenance of merinos rather than of the native sheep, the question assumes another aspect, under which we do not propose to examine it in this place. I think, however, that in localities where economical arrangements cannot be altered, and pastures cannot be improved, many rural establishments will find no advantage in substituting merinos for a good native breed, especially since the universal multiplication of the former will raise the price of good coarse wool in proportion to that of the finer sorts. I know that many assiduous farmers in several countries have for a long time been engaged in trials to improve the native breed by itself; but they have probably by this time fallen into the method of crossing with merinos. For slaughtering, the native breeds, especially certain varieties, are, undoubtedly, better than pure merinos; whch can never be brought to the same degree of size and fatness, or made to yield meat of so rich a quality.

The *merino breed,* which we may consider as naturalised in Germany, though not yet very numerous in its pure state, must, I think, be very well known to all who will read this work. In 1811 I published, by order of the Minister of the Interior, a "Manual of the Economy of fine-woolled Sheep" (*Handbuch für die feinwollige Schaafzucht*), which may be found also in the "*Annalen der Fortschritte der Landwirthschaft,*" Bd. i. s. 1. In this work I think I have said all that it is most important to say on the subject. If to this be added the works of Tessier, that of Ch. Putet, and the treatise by Poyféré de Cère, inserted in the "*Annalen des Ackenbanes,*" Bd. s. 641, a complete course of instruction on the economy of this improved breed of sheep will be obtained. To avoid copying my own observations and those of other authors, I shall here say but little on the subject.*

That excellent writer, Ch. Putet, has shown in the clearest manner the necessity of having pure breeds, free from foreign blood on the mother's as well as the father's side, and to take the rams from them not only when we wish to introduce the pure breed, but likewise when our object is to perfect that which we already possess. Not only does improvement proceed faster by means of such rams, but, moreover, the breed cannot be preserved from degenerating without the use of rams of unmixed race. Hitherto it has not been positively ascertained, whether, or how long, a ram of improved breed, but descended by his mother's side from sheep of this country, will retain his superior qualities, so far as to obviate the fear of degeneracy when fresh crossing is not resorted to.

Some Englishmen, particularly Dr. Parry, think that by crossing their own Ryeland and Southdown breeds, they have obtained a race, not only equal to the true merinos in fineness of wool, but superior to them in shape of body, and firmness and quality of flesh: they are likewise so confident of the permanence of this race, that they endeavour to perfect it within itself without having recourse to new merino rams. They say that, just as their noblest breed of horses, though originally obtained by crossing with Arab stallions, is at the present day possessed of qualities which render it much more valuable than the Arab race itself, so it will also

* Several merino sheep have this winter been killed on my estate at Genthad, on the borders of the Lake of Geneva, and their flesh has been pronounced by all who have eaten it, equal to that of the best sheep that our butchers import from France. The kind of food seems to have an essential influence on the quality of the meat. I have known Swiss wethers, of breeds whose flesh had but very little taste in their native country, to yield excellent meat after feeding for a year or two on our pastures. On the other hand, I am of opinion that the proportion of the quantity of meat and fat to the weight of the animal when alive, is essentially owing to the nature of the breed; and in this respect I consider the merinos as inferior to the German breeds mentioned by our author, and likewise to the Swiss. 1815.—FRENCH TRANS.

be with their sheep. The facts which they adduce do indeed powerfully support this opinion; but it must not be forgotten that the Ryeland breed was before possessed of considerable fineness, and that the price of their wool in England was only one-third lower than that of the finest Spanish wool: so that, in fact, this Ryeland breed was for a long time considered as of common origin with the merinos; and some persons were even of opinion that the merinos were descended from individuals belonging to it, which had been taken over to Spain. But even though the English have attained their object in so short a time, we are not warranted in anticipating the same result with our native breed.

In Spain, the merinos are not all alike; they are divided into two principal classes, the Leon and Soria breeds. The several flocks of the former of these also differ from one another in qualities; and though each may possess certain advantages over the rest, it must nevertheless yield to them in others. These finer varieties are also observed among the flocks of pure merinos in Germany, and owe their quality either to their origin in Spain, or to choice of individuals, particularly of the rams. The fineness and other qualities of the wool may be equal in these several varieties: but sensible differences are observed among them in the quantity which they yield upon an equal amount of food, and in their size, strength, and fitness for particular kinds of pasturage. Up to the present time, however, nothing positive has been established respecting this matter: for there has been too much design in the observations made upon it. As, however, in the selection of rams, every one endeavours to obtain the particular qualities which he has in view, these varieties will probably in time become more permanent and better characterized.

The varieties will probably become much more strongly marked in this country than even in Spain: for with us the classing of the male and female is much better arranged than it can be in the latter country, where it generally takes place promiscuously. The

English have shown how much the form and qualities of animals, particularly of sheep, are influenced by the selection of individuals for breeding. "Bakewell," says Lord Somerville, "seemed to have the power of modelling a sheep just as he liked, and then giving it life."

It is thus that some of our principal breeders of sheep work upon size of body, considering that a greater extent of surface will, under given circumstances, yield a larger quantity of wool. Others prefer smaller animals whose wool being of closer texture equals in quantity that of larger sheep; such sheep, even though inferior in quantity of wool, may, nevertheless, be satisfied with a smaller quantity of food, and thus a larger number of them may be maintained for the same cost. Some cultivators prefer short, others long, legs; and these points are really not so immaterial as some persons think. Short-legged sheep are more quiet while grazing; they are preferable for pastures situated at a small distance and close together. Long legs, on the other hand, enable the animals to walk more easily either to the pasture, or thence to the fold or sheep-house. There is a variety distinguished by a triple collar of wool round the neck, and usually by a large dewlap hanging in front of the chest: some persons set great value on this dewlap; others do not like it, because the wool which grows on it is of third-rate quality only. In some sheep, the wool grows down to the hoofs of the hind feet, and even to those of the fore feet; in others, only to the knees. Some persons regard this as an excellent quality, inasmuch as it indicates a disposition to produce abundance of wool; others, on the contrary, do not approve of it, because the wool which grows on these parts is of bad quality. But all breeders are agreed that these qualities are hereditary. It remains to be determined, by more accurate observations, the relation which they bear to the quantity and quality of the wool. Hitherto we have not, in this country, been able to appreciate the form and constitution of the body in the merino breed, or their disposition to produce meat and fat, since it has not been much the practice to castrate male lambs, but only ewes no longer fit for breeding. Quality and quantity of wool are undoubtedly the principal points to be attended to; it remains only to ascertain how far these qualities are consistent with the characters just mentioned. It is easy to agree in considering such and such a shape as excellent, without assigning to it any particular utility: but this is an affair of fashion, and therefore ephemeral.

The merino breed is distinguished from others by slower development, shedding its teeth later, not so soon coming to maturity, and being longer in attaining its full growth: its progress may, however, be accelerated by more nourishing food. On the other hand, sheep of this race live to a greater age, and become stronger than others. Merino ewes have been known to retain all their teeth till their fifteenth year, and produce healthy lambs at that age. This is certainly a rare occurrence; but these ewes may easily be kept till ten years old. Merinos are also distinguished by a peculiar laziness of disposition; even the lambs are less frisky than those of other breeds. These sheep are said also to be more stupid than others, because the ewes will suffer their milk to be drained by strange lambs, whereas those of our country will not readily allow any but their own lambs to milk them. This is by no means an unimportant matter; for the stronger and livelier lambs are apt to rob the weaker ones of their food. It is therefore very important in this breed that the lambs be all brought forth nearly at the same time, and possessed of equal strength.

For the rest I must, as already observed, refer to my *Manual of the Economy of fine wooled Sheep*, lately published.

Some persons are of opinion, that ewes may be covered without injury at the age of two years, or even a year and a half: others maintain that it should be deferred a year longer, especially for merinos, whose development is comparatively slow. The majority are of the former opinion; and it is certain that well-fed ewes may, at the age of two years, produce fine lambs without injury to their health. In Spain, this is the usual mode of proceeding. If any breeder in this country should wish to multiply a good breed quickly, or proceed rapidly with the improvement of his own, he would certainly do well to follow this method. On the other hand, it is undeniable that ewes which do not bear till their third year, grow larger, and acquire stronger constitutions; it is probable, also, that they live longer. Whoever, therefore, would obtain a large and vigorous race, should keep his ewes from the rams till they are three years old.

Rams are usually not allowed to leap till three years of age.

In the management of sheep, it is very desirable to have all the lambs born at the same season, and within an interval of four weeks; with merinos this is absolutely necessary. The number of rams in a flock must not, therefore, be too much restricted: the best proportion is that of one ram to twenty ewes.

The time of putting the ram to the ewes is determined by that at which we wish the lambs to be brought forth: sheep generally bear for twenty-one weeks and a few days.

Ewes generally get into heat for the first time in the sixth month after lambing. Certain late observers, especially Putet, recommend that this first inclination be taken advantage of; first, because impregnation may then be most safely relied upon; and secondly, because the healthiest lambs are obtained from the connection which takes place on this first indication of rutting. Others maintain the opposite opinion, considering it better to defer it till the second time that the ewe comes into heat; that is to say, till three weeks later, in order to give her time to recover her strength after suckling.

The former method would accelerate the lambing season by a month in every year; moreover, the rams would be too much excited in the hot season.

It is doubtless advantageous to have all the lambs born early, especially when we have in view the rapid multiplication of a breed, and intend the young ewes to be covered at the end of their second summer. But for this purpose, an abundant supply of good fodder must be laid up for the winter, in order to keep the ewes rich in milk till they can obtain pasturage, and to supply the lambs with the food best adapted for them. The fear of not having sufficient fodder is, perhaps, the principal reason why some cultivators like their ewes to lamb in March; for experience has quite removed the fear that lambs will be hurt by the cold of winter. Many experienced breeders have advanced the lambing-season to the month of December.

The rams are kept apart from the ewes, and amongst the lambs, till the season arrives. When the time is at hand, the rams are more substantially fed, before they are let in amongst the flock of ewes. Unless it be desired to make a selection in the individuals, I do not think it necessary to remove the rams during the day, and admit them only at night. If, however, we wish certain ewes to be covered by particular rams, we must adopt the method described at p. 47, and the following, of my *Manual of the Economy of Improved Breeds of Sheep*, (*Handbuch für Venedelte Schaafzucht*). When the time, which lasts about four weeks, is over, it is best to remove the rams.

At the beginning of her pregnancy, the ewe is satisfied with somewhat scanty fodder and pasturage: but as she advances in that state, she must be better fed. The more nearly ewes approach their lambing-time, the more gently must they be treated: they must on no account be hunted by dogs; and care must be observed in taking them into and out of the fold, that they are not squeezed in passing through the doorway.

Ewes require the greatest attention at the time of delivery. The signs which announce this event are, swelling of the generative organs, swelling of the udder, and formation of milk. They generally lamb without difficulty; but sometimes the labour is rather protracted. We must not, however, seek to anticipate nature by giving premature assistance: this can only be required when the lamb, or some one of its members, is badly placed in the womb, an accident which rarely happens when the ewes have been properly tended. But if assistance must be given, the person who renders it should be well acquainted both with the actual and the required position of the lamb, as well as with the manner in which he ought to proceed to rectify it; all assistance given without this knowledge is likely to do more harm than good.

The chief source of trouble, in many instances, is to induce the ewe to take to her lamb after delivery. This difficulty, however, only arises when the ewes have been badly fed: if they have been abundantly supplied with food, the superabundance of their milk induces them to push the lamb to their teats. In the contrary case, the ewe and lamb must be lodged in separate pens, and the lamb allowed to suck, from time to time, while the mother is held by her feet.

The success of the lambs cannot be better insured than by supplying the ewe, while suckling, with good and abundant food. It is said, however, that untoward results have sometimes arisen from over-feeding; this, however, has, in all probability, happened when the animals have previously been badly fed.

After three or four weeks the lambs may receive some additional nourishment; such as a mash of meal, or oil cake, and a little soft hay; the place where they feed is to be parted off with hurdles, wide enough to allow the ingress of the lambs, but not of their mothers; or the lambs may be fed when the ewes are away. The lambs should suck for eighteen or twenty weeks. Those which are weaned earlier for the sake of their mothers' milk, remain poor and sickly for the rest of their lives. Lambs should be weaned by degrees; for this purpose they are supplied daily with a larger and larger quantity of good fodder, or rich pasturage, and kept more and more from their dams. As soon as a lamb is completely weaned, it must be kept as far as possible from its mother, that they may not disturb one another by their bleating. A month will probably elapse before they forget one another completely, and the lambs lose the recollection of the teat: lambs have even been known to begin sucking again after a month's separation.

Male-lambs are usually castrated at the end of three or four weeks: the younger they are, the more easily is the operation performed. When the females are six weeks old, their tails are cut at four or five inches from the root, to prevent them from soiling themselves.

The age of the sheep is known by their teeth: the same organs are likewise used to designate them.

Besides the molar-teeth, sheep have eight incisors in the lower jaw, but none in the upper; this number they usually bring with them into the world: these first teeth are more rounded and pointed than those by which they are afterwards replaced.

At the age of a year, or a year-and-a-half, the two middle teeth are shed and replaced by two new ones of larger size. The animal is then called a two-toothed sheep or yearling. The latter name is also given to it when a year old.

After the age of two or two-and-a-half years, the two teeth next to those just mentioned are dropped, and larger ones come in their place. The animal is then called a four-toothed sheep.

At three or three-and-a-half years the third pair of teeth drop out, and are also replaced by larger ones, so that there remain but two of the original teeth, one on each side. The sheep is then said to be six-toothed.

In the following year the last two teeth are also shed, and the animal is then said to have a perfect mouth. The formation is then complete.

In the sixth year the teeth begin to wear away, the two in the middle becoming blunter and shorter. The teeth appear, however, to be longer, because the gums retract, but when examined closely, they are easily seen to be worn at the top. As soon as the teeth are completely worn away, and begin to decay and fall out in pieces, the useful age of the animal is past, and it must be got rid of. If we would preserve it longer in the hope of obtaining more lambs from it, we must feed it upon particularly tender fodder; by this treatment sheep may be sometimes brought to a very advanced age. The teeth then no longer continue close together, but have vacant spaces between them: the upper lip increases in size, and falls over the lower.

This mode of designating sheep by their teeth must be well borne in mind when we are talking to a shepherd: we must not, for example, confound a sheep of four teeth with one of four years.

A sheep less than a year old is called a lamb. A male of this age, which has not been castrated, is called a ram lamb; one which has undergone that operation a gelded lamb.

After the first or second year they are called yearling rams and yearling wethers.

Those which are set aside, not to be used for breeding, are called refuse sheep.

The feeding of sheep must be so arranged as to afford them, as far as possible, equally substantial nourishment throughout the year.

The ewes must, however, be somewhat better fed during the last stage of their pregnancy, and likewise while they are suckling lambs which are not fed in any other way. Nothing is more injurious to pregnant or suckling ewes than to be overfed at one time and half-starved at another. In the latter case all food of a highly nutritive character brings on disease. The observation of this fact has led to the recommendation of avoiding particular kinds of fodder and pasture-plants of very substantial quality; in reality, however, these plants are not injurious, excepting when the sheep are led by hunger to eat them with too great avidity. Good nourishment bestowed upon suckling ewes is almost always repaid by the produce of the flock; more, however, in the case of fine than of coarse-woolled sheep.

The proportion between the winter and summer feeding of sheep varies according to warmth of the pastures and the temperature of the year. In our climate it is usual to allow seven-twelfths for summer, and five-twelfths for winter: matters are, therefore, so disposed as to provide a sufficiency of fodder for 150 days. If the least use can be made of winter pasturage, especially on the autumn sowings, this quantity will usually be found sufficient. But as the spring temperature is very uncertain in this country, and we might find ourselves troubled to provide nourishment for the ewes and lambs, it is proper to reckon upon at least 160 days. Any surplus that may remain will not be lost: if the prolongation of pasturage in autumn, or its anticipation in spring, allow of any saving of fodder, the quantity thus saved will form a commencement of provision for the following year.

Pastures for sheep may be divided into natural and cultivated, or artificial pastures.

By natural pastures we mean those which have been formed by natural causes, and not intentionally disposed for the feeding of sheep: by artificial pastures, on the contrary, those which have been purposely formed and arranged for sheep to graze on.

The former class includes

(*a*). Natural open pastures usually found in dry elevated and mountainous situations.

(*b*). Pasturage in the woods.

(*c*). Pasturage on fallow and stubble lands.

(*d*). Pasturage on meadows, in spring before the first crop springs up, and also in autumn.

(*e*). Pasturage on the sowings.

(*a*). Natural open pastures are gradually diminishing in extent, in consequence of the progress of cultivation; only the driest and poorest parts are devoted to sheep, the richer portions being reserved for horned cattle, which cannot find nourishment on the former. Sheep are never pastured on the richer spots excepting at the end of winter and in autumn. When the sheep can be removed early enough in the spring, to allow a month to elapse before the horned cattle are admitted, the pasture is not injured, but rather improved; because the sheep lower the grasses which shoot up before the rest. Their dung fully makes up for what they take from the soil, and the smell of it, which is so disgusting to horned cattle, is dissipated before the grass springs up. Even a low damp pasture does not injure sheep in their first year, provided it be free from stagnant water, and they are not left upon it for too long a time.

Dry and upland pastures, particularly on mountains, which, on account of their steepness and the thinness of the layer of earth upon the rocks, are not fit either for ploughing or the feeding of horned cattle, are commonly devoted exclusively to sheep. They are, moreover, particularly beneficial to these animals, whose nourishment upon them often affords the most profitable means of turning the land to account. On these elevated grounds, however, we sometimes meet with marshy spots, beds of springs, ponds, or waters running on the flats between hills and mountains; such spots are very dangerous to sheep. Places on which marsh-plants grow should be carefully avoided, even when deprived of their moisture by the greatest heat of summer. Particular danger is to be apprehended from localities where a layer of dried mud conceals a marshy substratum from which there arise mephitic gases affecting animals of all kinds with various diseases, men with fever, and sheep almost instantaneously either with a disposition to the watery cachexia, or rot, very difficult to cure, or with other maladies still more quickly fatal. It is not in the rainy season that this danger is most to be feared, for sheep then find sufficient nourishment on dry soils, and avoid places of this description. But when the herbage on dry soils is withered, the animals are driven by hunger to damp spots; and shepherds, apprehensive lest their sheep should suffer too much from hunger, are too much inclined to allow them to go there. Merinos are decidedly more subject to this disease than our ordinary German sheep; it is, therefore, an indispensable condition in the maintenance of a flock of high-bred sheep to have all the damp places on these pastures drained by digging trenches and drainage-furrows, or at least to keep the waters within their proper bounds, and not allow them to cover the neighbouring lands with mud.

(*b*) *Pasturage in the woods* varies greatly in quality according to the nature of the soil, and the kind and thickness of the trees composing the wood. A thin wood is almost equal to an open pasture; but the more thickly it is planted, the worse does the pasturage become. When the soil is fertile, and the grass not choked, but only shaded by the trees, the pasturage is sometimes abundant; but its nutritive power is but weak, and thence it does little good to the sheep. Moreover, there are often marshy spots in woods. With the exception of primroses, nothing but hard dry herbage will grow under pine trees: sheep find, therefore, but scanty food where these trees grow. Such pasturage is, however, considered wholesome and capable of correcting the bad effect of damp places. Pasturage in thick woods is, however, very injurious to the wool, and therefore the owners of fine-woolled sheep do not allow their flocks to go into them.

(*c*). In ordinary rural establishments the principal food of sheep is derived from *pasturage on the fallow field:* the profit of sheep is, therefore, much diminished by all arrangements which prohibit fallowing. Hence almost all shepherds and amateurs of sheep are opposed to a system of cropping, from which fallowing is excluded, and particularly to the introduction of this system on the land of the peasant. It is for this reason that in almost all countries where the management of sheep forms a leading branch of rural economy, there exists an established usage, and even an obligation, of not ploughing up the stubbles till the latest moment—an arrangement by which the real object of fallowing is completely frustrated.

Pasturage on the fallow-fiel—is distinguished into that which takes place before the s ble is ploughed up, and that obtained between the fir nd second ploughing on the weeds and grass which t spring up. The former is undoubtedly the more abu ant of the two: the latter is agreeable to sheep, but la s for a short time only; the thin shoots are soon devoured by the animals. Some persons think that this description of pasturage is likely to be injurious, especially in wet weather; but I do not think that any such danger need be apprehended, provided only that we do not turn half-starved sheep on a fallow-field richly covered with grass, for then, especially in wet weather, they would probably eat to excess.

Sheep generally find plenty of food as long as the stubble is not ploughed up; but after this operation, the season of scarcity for these animals comes on. At this time most of the pastures are dry, because the greater number of grasses stop growing towards the middle of summer. The sheep must then depend on pasturage in the woods, the best places in which are therefore reserved for this part of the season. The ewes, however, gain but little strength on these pastures; it is therefore desirable to remove their lambs, reserving good pasturage in some spot or other for the latter.

After harvest comes *pasturage on the stubbles*, which is more or less nutritious according to the quantity of grass upon the field, and the number of ears which have fallen on the ground during harvest.

(*d*). *Pasturage on meadows*, sweet and well drained, is the most beneficial nourishment that can be given in spring to suckling ewes. The meadows used for this purpose are chiefly those which are irrigated with spring-water, because they soon become green, and the grass begins to grow by the end of March: the sheep are turned upon them as soon as they are sufficiently dry. Pasturage on such meadows, continued till the middle of April in a warm season, and the beginning of May in a cold one, is beneficial both to the sheep and the meadows, though some persons think that both are injured by it.* But marshy, sour meadows may undoubtedly be hurtful to sheep, even in spring. In autumn, it is rarely beneficial, and often dangerous, to turn sheep on the meadows: but such pasturage is then very useful for horned cattle.

(*e*). *Pasturage on the autumn-sowings* is never injurious to sheep, provided that it takes place in dry weather: in winter during a dry frost, and in spring on very rich sowings and a fertile soil. But on a well-managed sheep-farm, such pasturage should hardly be reckoned upon, because it may fail. Moreover, it should always be but moderately used, in order that the sheep may not be too much accustomed to it, for they will then refuse dry fodder, and suffer from hunger when they cannot get pasturage of this description. In many sheep-establishments which are but ill supplied with fodder, this circumstance is not regarded as inconvenient; on the contrary, it is thought advantageous to let the animals eat their fill for a few days, and save fodder afterwards. But this periodical scarcity is very injurious to the wool, especially that of Merinos, and still more to the lambs. Sudden change of diet may also injure the health of the sheep. They should, therefore, be well fed in the morning (but not upon straw alone, as some persons feed them), and allowed to eat but moderately of the pasture as a relish. This pasturage must be no less sparingly used in spring, when very thick sowing can be afforded, such as will not be injured by this mode of cropping, and appear adequate to form the chief support of the sheep till the other pastures are available. In this respect, it is particularly necessary to exercise careful superintendence over the shepherd, and give him precise instructions; for

* In our climate I have continually seen the first crop of sweet meadows greatly diminished when sheep have grazed upom them from the time of the latest frosts, that is to say, the beginning of April. Many examples likewise make me apprehensive lest in this country, pasturage on watered meadows of this description, if long continued, even in dry weather, and after the meadows have been well drained, may yet involve some danger of the rot.—FRENCH TRANS.

these people are much inclined to use such pasturage to excess.

In rural establishments, in which various descriptions of pasture must be used in succession, according to time and circumstances, it is of the utmost importance to be well acquainted with them, and to lay down a plan of the manner in which they are to be used for the sheep, according to seasons and the weather, unless, indeed, we are content to be absolutely guided by the shepherd. Under such circumstances, shepherds make great boast of their local knowledge, knowing that others, not possessing this knowledge, may easily do a great deal of harm; and if, by chance, they find out that the master appreciates their merits, then every thing must be conducted according to their fancies. Whenever, therefore, a proprietor wishes to make any change in the management of his sheep, or any other part of his rural economy, and at the same time render himself independent of the shepherd, it is absolutely necessary for him to examine carefully all his herbage and pastures, especially those of which he has the use on his neighbours' grounds by virtue of some right or privilege, and moreover, to make this examination at all seasons and in all weathers, in order to know the state of moisture of the land, and the unhealthy spots to be found on it. At the same time, he may make himself acquainted with the strength of vegetation of these pastures, the kinds of grass that grow on them, and lastly, with their situation and distance from the homestead, sheepfold, and watering-place. All this should be noted on the spot, and inscribed in the estate-book, with a reference to the plan.

The rights and privileges which the proprietor enjoys on other persons' lands, together with their extent and duration, must also be particularly noted.

A plan may then be drawn up for regulating the use of the pastures in such a manner as to give the greatest security for the maintenance of the sheep, and to admit of alteration according to circumstances, in case of its complete adoption being hindered by very bad weather, but always so as to obviate the necessity of submitting entirely to the will of the shepherd.

The best pasturage must be reserved for the lambs, the second-best for the suckling ewes, and the worst given to the barren sheep.

Under such circumstances, pastures of varied nature and considerable extent, present undeniable advantages, for they allow the animals to go from low situations, where the grass is rich, to dry, poor heights, and even into pine-woods, to correct the bad effect of the rich herbage. Shepherds who insist on the necessity of great extent of pasturage are right, even though the pastures should be faulty in some respects.

Artificial or cultivated pastures are formed in the places assigned to them in the system of alternate culture. It is only on these pastures that sheep can be grown with certain and complete success. When those kinds of grass and clover best adapted for pasturage are sown on these fields, all less useful plants ploughed up, and the soil properly drained, sheep find on them, at all seasons and in all weathers, a wholesome nutriment, which they eat quietly, without going far to seek it. The fertility of these pastures and their culture have been previously considered.

According to the extent of pasture required for a cow, the number of sheep which can be fed on a given extent of land may be determined, ten sheep being reckoned for one cow. This proportion may be safely relied upon if the sheep have also the use of pasturage on the stubble and fallow fields. As, however, the produce of the pastures is not the same every year, great certainty will be attained by reckoning upon a larger extent of ground, and reserving for cases of necessity a certain portion, which may be mown if not required for grazing. I have known an acre of pasturage to suffice seven sheep during the whole summer.

Sheep may be stall-fed in summer: this has been proved by unexceptionable trials. Such a mode of feeding is, however, attended with difficulties which most people would consider insuperable; difficulties, indeed, to which one would scarcely be warranted in exposing one's-self without having, from year to year, a supply of hay and straw enough for six months at the least.

There is another mode of making the sheep consume a crop of clover, tares, &c., on the ground: it consists in placing hurdles before them just high enough to allow them to crop the herbage to a certain distance by stretching their heads over. The hurdles are moved forwards as the sheep go on grazing.

The winter food of sheep consists of hay and straw. The straw contains very little nutriment, and is, moreover, less substantial in proportion to its greater freedom from weeds, its ripeness, and the care with which it has been threshed. The value of this pure straw is greatly exaggerated when it is said to be equal to half that of hay; this can never be the case excepting when the straw contains a large quantity of grain. It, however, fills the stomach and dulls the sensation of hunger when nothing of a more nutritious character can be given: indeed, there are many sheep-folds in which, from autumn to the somewhat advanced period of lambing, the animals are obliged to content themselves with pure straw, and such winter-pasturage as chance may afford them; but they come out from the winter season in a miserable state, yield but a very small quantity of wool, and that of coarse quality—fine-woolled sheep could not stand such diet. The straw of leguminous vegetables and buck-wheat is more nourishing, especially when the crops have been taken while part of their leaves remained green. This straw may therefore be used as a help in establishments which are short of fodder: in such concerns it is frequently given to sheep as a relish, and reserved for the lambing season; whereas, in rich establishments, it is used only at the beginning of winter in place of hay.

Sheep are, however, mostly fed upon hay in winter; and when a choice can be had, this hay is of the most nutritious quality, kept as green as possible, harvested in dry weather, and well preserved from mouldiness and all unpleasant smells. The hay of cultivated fodder-plants is also better for sheep than that of most natural meadows.

There is a great diversity in the quantity of hay given to sheep. In bad sheep-folds, 30 or 40 quintals are considered sufficient for the winter-food of 100 sheep. But in establishments where sheep of superior breed are kept, 75 quintals is regarded as the minimum of winter provision for this number of animals, making, for the 150 days during which the sheep are almost wholly stall-fed, 55 lbs. per day for 100 sheep, or rather more than 1 lb. for each.*

But experience shows that when the wool has acquired a great degree of fineness, and risen in price, it is profitable to give the sheep a more abundant supply of food, even if hay should be worth 12 groschen per quintal. A remarkable comparative essay on this subject is described in the second volume of the "Neue Annalen der Landwirthschaft," s. 123, in which fifty-one sheep, fed on a quantity of hay greater by $17\frac{3}{4}$ quintals than that given to fifty-one other sheep, yielded 75 lbs. of fine wool more than the latter;† but this hay, at the rate of 12 groschen per quintal, would amount to only 8 rix-dollars 21 groschen. It is worth while to try, by exact experiments, up to what point it may be found profitable to increase the food of sheep, and whether there is a maximum beyond which this amelioration of food ceases to be profitable. If the latter supposition be correct, any surplus food will of course be more advantageously divided among a larger number of animals. Some great amateurs of sheep regulate the quantity of food to be given to them only by their appetites, which, however, in animals that are always properly satisfied with food, is not so great as in those which are poorly fed. Others think that greater advantage is gained by keeping a larger number of sheep; this, however, may easily degenerate into a system of starvation. In determining this matter, regard should be had not only to

* A Berlin quintal contains 110 lbs.—French Trans.

† I have here omitted the calculation of the produce of wool, in which I think there is a misprint in the original. It was estimated at 70 rix-dollars, 10 groschen.—French Trans.

the quantity of wool, but also to the size and quick growth of the lambs, and the increase of flesh and fat in those which are not intended for breeding.

Two quintals of hay per head is usually regarded as the most advantageous quantity for fine-woolled sheep of ordinary size, which are not supplied with any other food; some farmers, however, consider this quantity too large, and think that it may be more profitably divided among a larger number of animals: they even look upon $1\frac{1}{2}$ quintal per head as verging on extravagance. But it should be remembered, that by giving more hay we save straw, and therefore, when the latter is scarce, it may be economical to increase the quantity of the former.

It is also agreed that a sheep requires 3 lbs. of dry fodder per day: if its food be reduced below this quantity, it suffers from hunger, which is always injurious. But a ewe will eat $3\frac{1}{2}$ lbs. of dried hay, with good appetite. The larger the proportion of nutritious hay to straw in this allowance, the more will the animals thrive.

In valuations, the feeding of sheep is sometimes put down at a price much lower than that which it really costs: but this is not easily discovered till more exact information has been obtained; for, at all events, when the shepherd receives part of the produce of the sheep-fold, only the amount of the valuation is put down: whatever is to be added to it is reckoned apart, and the shepherd pays his portion of it: no shepherd who understands his business will object to this apparent sacrifice.

Where a sufficiency of hay cannot be obtained, *grain-feeding* is usually adopted, to make up the full quantity of food. Oats are usually preferred; but rye and barley, in proper proportions, are no less advantageous to sheep. In places where large quantities of peas, tares, beans, or buckwheat, are cultivated, they constitute the most usual kind of grain-food for these animals. Mashes of oil-cake are of great service, especially for lambs and suckling ewes: the refuse of the brandy distillery is also useful; but it must be given with caution, and before it turns sour: many farmers have found that, when acid, it produces a bad effect upon the milk.

Corn is sometimes given to sheep in bundles, either unthreshed or only half-threshed; but the quantity cannot then be accurately measured. The grain is, however, more commonly given in the naked state, but mixed with chaff and slightly moistened. Sometimes, also, it is a little swelled by soaking in water; this method is particularly adopted with the seed of pulse. Other persons prefer giving it in the ground state, mixed with cut straw, or in a mash. Provender consisting of chaff and refuse corn is sometimes given to sheep.

If the price of grain be somewhat high, this mode of feeding will be among the most expensive that can be adopted: it is therefore resorted to only at lambing time, or in cases of necessity, or, as some persons recommend, for curing sheep attacked with the rot.

Instead of depending on grain, it is undoubtedly better to cultivate root-crops of various kinds, and use them to supply the place of a portion of the hay on which sheep are to be fed; perhaps even half. Numerous experiments have shown that all the ordinary root-crops are particularly beneficial to sheep, and preferable to all kinds of dry fodder, especially during suckling-time. Sheep are never injured in health by these roots, but digest them easily, as is proved by the readiness with which they eat them, especially potatoes, when once accustomed to them. When these vegetables are used in place of hay, their quantity must be proportioned to their nutritive powers, as already explained. It has been abundantly proved, indeed, that they may be used altogether instead of hay; but if so, the sheep must be plentifully supplied with straw; and, after all, they thrive better when fed on roots and hay alternately. Sheep fed daily on $1\frac{1}{3}$ lb. of hay and 1 lb. of potatoes, or 1 lb. of hay and 2 lbs. of potatoes, together with a good supply of straw, have been found to thrive particularly well, and give plenty of wool and milk.

Good pea, tare, or lentil-straw may, however, be used instead of hay when the sheep are fed on roots.

Acorns and *horse-chesnuts* afford nourishing food to sheep: they are particularly recommended for those which are attacked with the rot or watery cachexia. They are given in the quantity of about a pound per day, either in their natural state, or after being soaked for some days in water, and then dried in the oven: this treatment causes the husk to separate, and removes the rough taste.

In some countries, sheep are fed in a great measure on the leaves of the elm, lime, poplar, maple, ash and alder trees, the relative utility of which varies in the order here mentioned. The branches are cut in July, tied up in bundles, dried, and collected in heaps; they are then housed in a barn, to be given to the sheep as a supplementary food, particularly at lambing time. In places where this kind of food is regularly used, the trees which furnish it are arranged in three divisions, from one of which the leaves are gathered every year. When the sheep have eaten the leaves, the wood is used for burning.

Salt is undoubtedly useful to sheep at times, but should be regarded rather as a medicine than an article of food. The desire of licking salt is manifested by sheep precisely at the time when they require it. The opportunity of doing so is afforded to them without spreading salt upon their food, by suspending a lump of rock salt in the fold, or making cakes of dissolved salt and meal, baking them, and either hanging them up in the same manner or putting them in the mangers. Brine is also made of a solution of salt and an infusion of aromatic herbs, viz., wormwood, buckbean, gentian, holy thistle, camomile, marjoram, rue, balm-mint, thyme and feverfew. This liquid is placed in a wooden porringer; a pound of it will suffice a sheep for a year.

These animals require drink as much as solid food, and should have the opportunity of drinking often. It is only when, according to old-fashioned custom, they have been allowed to suffer from thirst, that they are likely to injure themselves by drinking to excess; such injury would be most likely to result from their drinking stagnant or marshy water. When fed on succulent vegetables they are less inclined to drink than when they live on dry fodder. In winter, they are much disposed to eat snow; it agrees with them very well.

Dark, confined, damp stalls, such as have been too long used for sheep for fear of their suffering from cold, are highly injurious to their health. Sheep are naturally protected from cold, and they enjoy fresh air and light more than any other domestic animals. It is only when weakened by long confinement in a warm, damp atmosphere, which throws them into a state of perspiration, that they are injured by sudden exposure to cold. All intelligent persons are now convinced that light, airy, spacious sheepfolds are absolutely necessary, and that nothing need be apprehended from their coolness. Well-fed sheep may safely be exposed to a temperature considerably below the freezing point.

The experiment of keeping sheep out in the open air at night, according to the English custom, has been tried both in France and Germany. M. de Trembicki, of Lomna, near Warsaw, particularly deserves the thanks of the public for his attention to this matter ("Annalen des Ackerbaues." 1805. I. 721.) An experiment of the same kind is recorded in the "Annalen des Ackerbaues," bd. xi. s. 452. But notwithstanding the possibility of keeping sheep out at night, a well-aired fold is much more advantageous to them; this has been shown in the ninth volume of the "Annalen," s. 83, by his Highness the Duke of Holstein Becq. Such a covering forms a useful protection to the newly-dropped lambs, especially in the very cold season: it likewise keeps off rain and snow, and prevents succulent fodder from being spoiled by frost. In rainy weather a smaller quantity of litter, also, serves for sheep in the fold, and their dung retains its moisture better.

The principal requisites of a good sheepfold are sufficiency of room, currents of air so directed as to afford perfect ventilation without exactly coming in contact with the sheep, and a space or yard in front in which they can enjoy the open air as often and as long as they like. Some persons have built magnificent sheepfolds, with wide and numerous windows. There is certainly no objection to such folds; but sheep may be just as well kept in ordinary folds, built according to the old plan, provided the necessary ventilation be supplied, the doors be left open, and the sheep have liberty of going in and out at their pleasure. In large sheep folds it is very convenient to have separate stalls or compartments for the several descriptions of animals. The fullest directions, in an agricultural point of view, respecting the construction of sheep folds, will be found in Gilly's "Anweisung zur landwirthschaftlichen Bau Kunst von Friedrici."

Among the various modes of constructing mangers, the following is, in my opinion, the most suitable:—A board, about 16 inches wide, is supported on four tressels, and bordered with a lath about two inches deep. This board serves to retain the hay dust, and to feed the sheep with short fodder and roots. Double racks, joined together, are placed upon it. These racks are about 12 inches asunder at the bottom, and 10 at the top, so that they incline towards each other, and not outwards, according to the old construction. This arrangement not only obviates the inconvenience of anything falling into the wool of the sheep when they pull the fodder out of the rack, but also prevents them from leaning over one another to eat, and thereby soiling each other's fleece. By this arrangement, also, the animals are prevented from jumping into the mangers, as they are very much inclined to do. The double rack is suspended by cords passing over a pulley attached to the rafters, or else to two cross-bars, by means of which it is raised above the board when the sheep are to be fed on short fodder.

I have elsewhere spoken of the advantages and inconveniences of night-penning as a means of improving land. That this treatment may not injure the health of the sheep, it must be adopted in the warmest part of the year only and in dry weather; moreover, the sheep must not be too crowded in the pens, but each must have a space of ten square feet. It is advisable not to expose them to a thunder-storm, but to take them back to the fold when such a shower is perceived to be coming on: but a sudden heavy rain does not hurt them nearly so much as a long continuance of cold damp weather. Sheep must never be penned on damp ground: the drier and more sandy the soil, the less is it likely to injure them.

A flock of sheep includes the following divisions:—

1. Breeding ewes.

2. Wethers, with which also the rams are usually kept.

3. Year olds.

4. Lambs—these are kept separate during the summer only, because at the beginning of winter the lambs of the previous winter are taken into the division of the yearlings.

5. Fatted sheep, where fattening is attended to, and there are pastures fit for that purpose.

1. The ewes of the first division are distinguished according to age, and entered upon the register accordingly. The distinctions are as follows:—

(*a*). Old or superannuated ewes.

(*b*). Full-mouthed ewes which have got their eight large incisors.

(*c*). Six-toothed ewes.

(*d*). Four-toothed ewes.

For the winter the animals are put in the division to which they properly belong in the ensuing spring only. Thus, the lambs born after the winter of 1809 are regarded as year olds of the following autumn, and placed in the corresponding division for 1809-10. In the winter of 1810 they are classed (such at least is the custom) among those fit to receive the ram; that is to say, among the four-tooth ewes, though in reality they have yet but two teeth. A similar method is pursued with the other classes. Moreover, in a sheepfold where improvement of breed is attended to, the ewes are distinguished according to their generations, which are distinguished by peculiar marks; viz., those of pure breed, and those of the fifth, fourth, third, second, and first generations. They are distinguished as follows:

OLD OR SUPERANNUATED SHEEP.

Pure	10
Of the fifth generation	8

FULL-MOUTHED SHEEP, WITH EIGHT TEETH.

Pure	20
Of the fifth generation	40
„ fourth ditto	60
„ third ditto	60
„ second ditto	40
„ first ditto	20

The six and four-toothed sheep are similarly distinguished.

Sheep are usually marked and counted three times a year:

1. At the beginning of winter, when those which are to be drafted are separated from the rest.

2. In spring, when winter-feeding is nearly over; the sheep to be drafted after shearing are then marked.

3. At shearing-time.

The register is consequently revised, or the number of sheep in each class and division noted, three times a year. Some persons perform this revision every month, but this is unnecessary, provided that care be taken to note once a month all changes which happen in the fold, and every increase or diminution of numbers.

The state of a flock during winter is considered permanent. In summer, the number is increased by that of the lambs, but it is also diminished by losses and removals which have taken place during the spring. If the flock consist of 1,000 sheep during winter, pasturage must be provided for at least 1,300.

Wethers, or sheep for fattening, are regarded in this country but as an accessory though necessary branch of sheep-husbandry. It is true that we sometimes meet with fattening flocks, consisting entirely of wethers and drafted sheep, bought for the purpose from owners of flocks, and fattened either for summer or winter; but sheep-husbandry is rarely undertaken with fattening for its principal object, as it is in England. The principal object with us is the wool: breeding and fattening are resorted to only from necessity. The multiplication of sheep for the former of these purposes is so rapid that our markets are glutted with drafted sheep; but the flesh of these animals being of indifferent quality, the taste for it has been lost; and the low price of bad mutton causes a depression also in that of good, at least in the government duties hitherto in use. Hence it can rarely be profitable in this country to rear sheep especially adapted for fattening, and devote to that object the care which we bestow upon the wool, or pursue it, as the English do, to the detriment of the latter.

There is great diversity in the disposition to fatten and the goodness of the flesh in the several races of sheep. In England there are breeds of which ewes produce one or even two lambs in their second year, suckle them, and become fat either by autumn or during the following winter without being covered a second time. Such sheep are considered the most profitable of all; for the price of their meat well repays the cost of both winter-feeding and pasturage; the wool is regarded as only of secondary importance. This property does not, however, belong to all the English races: there are some which cannot be profitably fattened till the third or fourth year. There is also great diversity in the quality of the meat. Good mutton should not be spongy or very porous, but soft, of delicate fibre, and succulent. A moderate quantity of fat, mixed with the muscular fibre, is much esteemed; but the excess of that substance, which shows itself on the outside sometimes in layers five or six inches thick, is fit only for the poorer class of people, who use this fat to eat with the leguminous vegetables on which they live.

Many Englishmen consider goodness of flesh and disposition to fatten incompatible with fineness of wool.

This opinion is not, however, universal: some persons in England think that goodness of flesh and wool may be united. They have, however, seen abundant proof that the merino breed is very defective in these respects, and upon a given quantity of food produce flesh inferior, both in weight and quality, to that of any other breed. It is commonly considered that the greater value of the wool does not compensate for these disadvantages, at least in the system of English husbandry. Many farmers, therefore, without directly opposing the introduction of the merino breed into England, think that an intermediate race, possessing both qualities, might be formed by crossing, and a proper selection of individuals.

With us, in Germany, the production of meat is but a secondary consideration: generally speaking, we have no breed particularly famous in this respect. We must, however, remember, that upon a given quantity of food the pure merino race does not gain so much flesh, or produce meat of so good a quality, as the larger variety of our native breed. The wethers of the former race evidently make less progress than those of the latter; and when a butcher is permitted to make a selection amongst a flock of mixed sheep, he will reject all the merinos, unless they have already gained a large quantity of wool, a circumstance which he very well knows how to appreciate.

Considering the great advantage which the merinos present by the quantity of wool which they yield, we shall scarcely be prevented by the circumstance just mentioned from introducing the breed into our establishments, unless, indeed, a change of circumstances should greatly increase the price of mutton as compared with that of wool.

If, however, peculiar circumstances of husbandry should induce cultivators to direct their attention to the fattening of sheep, and to turn the milk of their ewes to account, it would be no less advantageous to have a good native breed, perfected within itself. When our only object is to keep wethers for fattening, and buy them for this purpose of breeders, we shall undoubtedly find the native breed the most advantageous, especially when we intend to fatten quickly, and therefore reckon but little on the wool which the sheep may gain during fattening.

It may also be found advantageous to keep sheep for fattening in localities where the pastures are rich but not very healthy, such indeed as to cause some danger of the rot or watery cachexia; or on a moist rich soil, where the stubble-lands and meadows yield abundant second crops, and at the same time lean sheep can be purchased at low prices, and sold at a good profit when fattened. When large quantities of root crops are cultivated, it may be found advantageous to fatten sheep during winter and sell them in May, for at that season there will seldom be any difficulty in finding a market for fatted sheep, particularly in the neighbourhood of large rich towns, in which, at this time, good mutton is highly prized.

When the fattening of sheep is undertaken, it is best to bring it to perfection as soon as possible, and frequently to renew the flock. Wethers kept for a whole year will rarely pay for their food, whether they are stall-fed or pastured. If, therefore, we possess fattening pastures, they must be liberally used, that is to say, we must not put too many sheep upon them. A portion of the pastures must be reserved in order that the sheep may be placed upon them when the grass begins to get low on those which they have previously occupied: drafted ewes may then be put upon the latter to consume the rest of the grass. If this pasturage be not sufficient, additional food must be given in the fold, so that the fattening may be complete in eight or at most in ten weeks. If the fattening take place in winter, the sheep must from the first be supplied with as much food as they will eat; it is astonishing to observe the quantity that one of these animals will consume when in the middle of fattening. But fodder thus given will pay its expenses much better than that which is parsimoniously applied, so as not even in four months to bring the sheep to the degree of fatness which they might attain in two. Twelve wethers, of the native breed, which I once put upon trial in my sheepfold, intending them for use in my own house, were fed with a scheffel of potatoes and a quarter quintal of hay per day: in six or eight weeks they became so fat and produced meat of so good a quality, that all who ate of it at my table declared that they had never eaten meat more succulent or of more agreeable flavour; they found out, in short, how it is that the English set so high a value on good mutton.

Wethers which are to be fattened at home should, while they are lambs and year olds, be kept in such a manner that they may attain, during the time, to their full size and strength. The better sort of our native sheep may, by good feeding, be raised to an extraordinary degree of size and weight. This is proved by the wethers sometimes kept alone in stables from their first year to the time when they are put up to fatten; they may then be more sparingly fed. When sheep are bought exclusively for fattening, success depends chiefly on the selection and price of the animals purchased. In general, it will be found advantageous to buy the largest sheep that we can feed, even if we pay a higher price for them.

On large sheep-farms it is necessary to have a master-shepherd to overlook the whole; he usually receives a part of the produce, and is considered responsible for the success of the whole concern. He has under him shepherds to look after the suckling ewes, a shepherd for the wethers, one for the year olds, and another for the lambs—the last is usually a boy.

The shepherd's occupation is in some respects a kind of trade, but it is often hereditary. The children of shepherds acquire from their youth a certain affection for sheep, and a peculiar tact in overlooking them; they become early and practically accustomed to the shepherd's life, often, indeed, so far as to unfit them for all other occupations. A good shepherd of this kind is certainly preferable to one who takes up the occupation at a later period of his life, and has to acquire the tact of watching sheep. The only thing to be regretted is, that certain prejudices and superstitions become inherited from father to son, and can scarcely be eradicated by the most palpable demonstration. Frequently there reigns among them a certain *esprit de corps* which induces them to combine for the purpose of deceiving and injuring their masters. A man possessing the qualities of an intelligent master-shepherd, but free from these prejudices and this party spirit, is a most valuable acquisition, especially where the cultivator cannot exercise a minute inspection over his sheepfold, and direct his shepherds in the minute details of their duty.

In some countries the master-shepherds are so corrupted that it becomes necessary to select young persons of good character, and either train them up one's-self to the employment, or apprentice them in a well-conducted establishment in some other country. It is much to be wished that the schools of shepherds, so long wanted, and so often proposed, were actually established and organized. As shepherds have, from the earliest times, possessed the confidence of the people for treating the diseases of animals and even of men, and as they make use of various superstitious remedies, and even perform operations, this confidence might be turned to account by furnishing the pupils with some instruction in the veterinary art. They might then to a certain extent follow the occupation of a veterinary surgeon, which can never, except in certain countries, furnish full employment for any one.

At the present day, the inconvenience of allowing the head-shepherd, as well as the other servants, to keep sheep in the flock on their own account, is generally admitted. When such a practice was permitted, it was perfectly natural that the sheep belonging to the shepherd should be always the best, his lambs the finest, and that all the animals that died were not his but the master's: all control, in short, was impossible. The custom was, however, not easily abolished, because all qualified shepherds insisted on its preservation, and it was consequently difficult to obtain one on any other terms. It was finally prohibited by law in the Prussian and several other states, any proprietor who should establish or perpetuate the practice being made liable to heavy penalties. The shepherds were therefore obliged to submit, and accept other conditions.

It was then determined what proportion they should receive of the total produce of the flock, a portion which they were consequently obliged to purchase without having sheep especially belonging to them. They were also obliged to bear their part of the accessory expenses, and a certain quantity of hay was appointed to be supplied to the flock without payment. Everything beyond this, such as salt, grain, &c., as well as all incidental expenses, were to be borne in common, so that the shepherd paid his proportion of them. This arrangement binds the interest of the proprietor to that of the shepherd; it amalgamates these two interests as it were, and prevents fraud, or at least throws obstacles in its way. It, however, occasions some difficulties in the appointment or dismissal of the shepherd, particularly when the establishment is considerable, and has for its objects the increase and improvement of the breed; for in either case a valuation will be necessary, and the shepherd who leaves has a right to claim his part in the increased value of the flock, since he has contributed to the expenses by which this increase has been produced.

Some persons allow the shepherd a certain portion of the produce, without obliging him to purchase part of the stock, sometimes even without requiring him to pay his portion of the incidental expenses.

If the proprietor be willing to exercise a very careful superintendence over his sheepfold, and in some measure to take upon himself the office of director, or if he employ a clever assistant, he may engage men at fixed wages, and feed them or allow them a certain quantity of provision for their maintenance. In order to interest them in the success of the sheep-husbandry, it is a good plan to allow them a specified gratuity for every lamb that they rear in health to the beginning of winter.

It is of great importance that the shepherd train his dog well, and have him perfectly under command; for a dog which disturbs a flock at improper times may completely derange it.

The washing of wool on the sheep's back is always very imperfect, and is, therefore, adopted only to take off the grosser part of the dirt, which in well-tended flocks of fine-woolled sheep ought not to be tolerated. Wool is more or less cleansed by this washing. This circumstance raises or lowers the value of the wool in the eyes of experienced connoisseurs; but more complete washing diminishes the weight, and the loss which thence results is often more than an equivalent to the increased value of the wool. The chief inconvenience of washing on the back is the injury which it does to the animal's health in bad weather; a circumstance which it is not always possible to avoid, if the time for taking wool to market should not admit of delay in shearing. Frequently when perspiration cannot be completely reestablished before shearing, its suspension throws back the natural and even the internal grease of the wool. But the use of this washing is so completely established in Germany, and so generally recognized in the trade, that it would be difficult for a private individual to dispense with it. Our wool is not purchased unless it has undergone this washing, and we have not the necessary establishments for cleansing it thoroughly; moreover, if we even attempt this complete washing, purchasers will not usually pay the price which it is really worth, according to its actual weight, because they prefer to perform this last washing themselves when they sort their wool. An opportunity should be taken, at a time when wool is much in request, for the proprietors of the best flocks to unite for the purpose of selling their wool either in the unwashed state or when thoroughly washed after shearing, and of establishing in every country where sheep are abundant the arrangements required for complete washing; these arrangements are now well known. It has been found that wool, when thoroughly washed after shearing, loses in weight about 54 per cent., provided it has not been previously washed on the back. In the latter process, the wool probably loses about 25 per cent. of its weight in the unwashed state.*

The success of washing on the back depends partly on the method adopted, which is variable—partly on the care bestowed upon the operation, and partly upon the water. Hard water has but little effect on the grease and dirt contained in the wool. Soft water, on the contrary, especially if it be soapy, renders the wool much whiter and cleaner; this is also the case with the water of the well at Mögelin, of which I have had occasion to speak in the *Annalen des Ackerbaues*, bd. x., s. 390.

To diminish the ill effects of washing on the back with regard to the checking of perspiration, it is of great importance for the health of the animal, as well as the quality of the wool, to endeavour to restore perspiration before shearing, by keeping the animals warmer and feeding them better than usual; if possible, also, an interval of a week should elapse between washing and shearing, particular care being taken to prevent the sheep from getting dirty again.

Opinions are much divided respecting the comparative advantages of shearing twice or only once a year. With Merinos, and sheep of improved breeds, the practice of shearing twice a-year has been generally abandoned; lately, however, some persons, who are in the habit of feeding sheep very plentifully and on very substantial food, have resumed it, because the wool of their sheep grows so fast and becomes so thick, that the animals are less inconvenienced by the double shearing than by the length of their wool. With well fed native sheep an increase in the quantity of wool has been obtained by two shearings, estimated by some persons at $\frac{1}{10}$, and by others at $\frac{1}{12}$ of the whole. In some countries it is thought that the wool obtained by two shearings is inferior to

* The amount of this loss varies according to race, country, kind of food, and the degree of cleanliness in which the sheep are kept. Merino wool sometimes loses five-eighths or three-quarters of its weight by complete washing, when the animals are well fed and the wool is very greasy.—French Trans.

that of one year's growth; in others, on the contrary, this is denied: the difference of opinion arises, no doubt, from the various kinds of manufacture in which the wool is used. Hatters prefer short wool. Sheep accustomed to be shorn twice a year often lose their wool in the spring following the autumn in which the shearing has for the first time been omitted; it must then be pulled off by hand. This inconvenience is much more perceptible when the sheep graze in woods or among bushes. Shearing too early or too late always produces a bad effect on the animal's health; the only remedy for the mischief is a supply of very succulent food.

To obtain the proper quantity of wool, it is important that the sheep be shorn close to the skin, and as carefully as possible, so that no wool may be left on the body in stripes. Skilful and practised shearers must be employed, and well looked after; this the shepherd will always do if he is to have part of the produce of the wool. The form of the shears and the equality of their blades is also of considerable importance.*

The shearer is usually paid so much per head, four or six pfennings.† A moderate addition to this sum will be well expended, if we can ensure by it that the sheep will be more completely shorn. Shearing executed by statute-labourers is, as may be conceived, rarely performed with care.

When a flock contains sheep of various degrees of fineness, they must be separated. The rams, wethers, ewes, and year olds are also separately shorn, and the wool of each class is kept separate.

In this country it is not usual to pick the wool, and put by itself that which belongs to each part of the body. A few fleeces are commonly placed one upon the other, so as to form a heap weighing about twenty pounds; they are then folded into bundles, the short clean wool being placed in the middle. Each bundle is tied with

* Excellent *shears* are now made at the manufactory of Schickler, in front of the Eberswold at Neustadt, A.

† About three farthings or a penny.

thin pack-thread; or else the wool is put, without tying, into sacks.

In flocks of high-bred sheep an exact account is taken of the weight of wool of each animal, in order to determine its value accordingly, and make a proper selection of individuals for breeding; for richness of wool is probably an hereditary quality. This opinion is in reality supported by experience, so far at least as weight depends on thickness (that is, on the number of fibres). The length of the wool, by which its weight is no less essentially influenced, depends on the food and health of the animal.

Merino wool is heavier in proportion to its bulk than that of our native sheep. But if a sheep of our country give less weight of wool than a merino, the deficiency will doubtless be found to arise from its having been less substantially fed. Upon equal food, our best native sheep seem always to yield a larger quantity of wool.

For the particular care required for merinos, and the mode of estimating the value of these animals, and of their wool, I must refer my readers to the works already cited.

HORSES.

All that relates to the breeding, training, and management of horses, has been fully treated by many learned and intelligent men who have devoted themselves to this branch of knowledge. We are, however, still in want of a fundamental and scientific development of this branch of rural economy—a treatise which shall furnish a clear and exact summary of it, and distinguish that which is conformable to nature from that which is founded on prejudice; for in this branch of husbandry we meet with prejudices no less deeply rooted than those which beset us in others. I have not the presumption to attempt such a summary; and this is certainly not the place for a treatise of sufficient extent to include all that is necessary, I shall therefore content myself with noticing what the farmer, in his individual capacity, requires to know of the breeding and feeding of horses.*

I cannot, therefore, undertake to give a description of the breeds of different countries, or of those which have been formed from them by selection of individuals, or by crossing.

The farmer's horse should be thickset, short, with broad chest and rump, round, muscular, and nervous; but not, as some persons think, large-boned. He should be not fiery, but rather lively; and above all he must be persevering and hardy, so that even when subjected to extraordinary fatigue, or badly attended to and poorly fed for a time, he may be able to put up with these inconveniences without being weakened or losing his health. A good foot is an indispensable qualification. The horse's strength must be proportioned to the loads which he has to draw, or the kind of soil on which he works. Strength, however, does not always depend upon size: there are many small horses which, when harnessed with others of larger stature, will beat them, and compel them to give way: but, as it is said, a large horse fills his harness better, and when free from blemish, is usually stronger, and takes longer steps. Large horses, however, require more food; and, on this account, those which are smaller, not from poor feeding, but by nature, are preferable, provided they are not to be ordinarily employed in very heavy work.

There is greater difficulty in finding a breed of horses perfectly well adapted to agriculture than one of higher character; because attention has everywhere been directed to the latter, to the exclusion of the former. A good hardy race of plough-horses has been too often mixed with one altogether unfit for the purpose, even by those who are most zealous in the breeding of horses. In the national studs which many sovereigns have established to the great advantage of their subjects, the object usually aimed at has been the production of good riding-horses;

* The best work hitherto published on this subject is undoubtedly that of "Naumann über diè [vorzüglichsten Thelle der Pferdwissenschaft." 3 Theile. Berlin, 1800-1802. A. This want has been supplied by Mr. Youatt's book on "The Horse."

and in most cases the choice of stallions has been made with too little regard to the nature of the breed already existing in each district, the mode in which the animals were treated, and the nature of the pastures.

The very sturdy race of horses once common in Mecklenburg is no longer found, excepting on particular estates and rural establishments of that country, and perhaps, also, in Pomerania. In the former country it is sometimes found in a state of higher breeding, without, however, having lost those qualities which render it fit for agricultural purposes. The Holstein horses, often called Mecklenburg, rarely possess the qualities which the farmer looks for: but there is a race of Danish horses, known by the name of Wasserdenen, which is perhaps stronger and hardier than any other. Lithuanian horses are strong and robust, in proportion to their size; but, for the most part, too small. I am not in a position to form a judgment on the ordinary race of agricultural horses to be found in other parts of Germany.

In the first volume of this work I have considered the question, how far the breeding and training of horses can be an advantageous occupation for the farmer. When once a race well adapted to agriculture has been obtained with a stallion who goes quietly with the mares that he serves, and covers the working-mares at proper time, I am persuaded, from the considerations adduced in the same paragraph, that the rearing of foals on pasturage proper for the purpose, or even in the stable, will be found profitable: if, at least, the advantages of a uniform and well-known breed be taken into account. It is this system of breeding, and not the formation of a stud, that we here consider. The mares and stallion are to be kept as working horses, breeding being regarded merely as a secondary object.

A mare may receive the stallion when she has completed her third year, so that she may foal at the age of four years. But for a working-mare, it is better to defer it till the fifth and sixth year, so as not to try her strength too early, and in two ways at once. Mares may very well produce a foal every year; but once in two years is often enough for those which work. They are covered early in the season—in February, if possible—so that they may foal at a time of year when their work can be dispensed with, and they can be properly treated. They must then be fed in the stable, and on very substantial food. The practice of making mares foal in May, so that they may have the advantage of green grass, cannot be adopted with plough-horses.

The time when the mare is in her greatest heat must be carefully observed and taken advantage of, as with cows: this can be done only when there is a stallion on the spot. This usually shows itself from the eleventh day after parturition, and the mare is then particularly disposed to take the stallion. It is from this cause that mares, though they go with young nearly a year, are capable of producing a colt every year at the same time.

It is a very bad plan to have a mare covered twice in the day, or generally even during the same heat, provided she has been already well covered.

The principal sign which indicates that a mare has conceived is, that she rejects the stallion, even while still showing some sign of heat. A mare in foal usually exhibits a certain degree of laziness: she stales frequently, or at least shows a desire to do so. After the lapse of a fortnight, the udder and veins leading to the teats usually swell: this symptom lasts for a week, and then disappears. At the end of the sixth month, the hinder part of the body enlarges, so that the circumference of the part near the hind-legs becomes as large as that immediately behind the fore-legs: this, however, is not always the case.

In the eighth month the pulsation of the foal may be sometimes felt on applying the hand against the flank of the mother while watering her.

A mare in foal may be used for all ordinary kinds of work: care being taken not to let her get overheated, and never to give her bad food. After the tenth month, however, she must be more cautiously worked; particular care being taken that she be never struck, jerked, or made to take violent efforts; her food must also be nourishing, and not inclined to swell. Finally, towards the end of the month, she should have ground corn in her water, to favour the secretion of milk.

When milk appears in the udder, and hollows are formed on both sides of the tail, we may know that delivery is at hand: its approach is also manifested by the restlessness of the mare. She is then usually taken to another stable, where she is provided with soft litter, and coaxed to lie down; this, however, must never be effected by force. Without actual acquaintance with the art of delivery, no one should attempt to assist her, still less to use violent means, such as pinching her nose during the efforts of parturition. If the head of the foal has made its appearance, the extrication of the other parts may, if necessary, be facilitated by stroking gently from above downwards.

If the umbilical cord do not separate spontaneously, a ligature is passed round it, at two inches from the foal's body, and it is cut at an equal distance beyond the ligature. No attention is paid to the after-birth, even if it should be a long time coming away.

The foal is usually sprinkled with salt, to induce the mother to lick it.

A warm wash, made of bran, is then immediately given to the mare; she is supplied with it in small quantities at a time, and often.

The mare while suckling must be fed with fodder of excellent quality, and a mash composed of ground rye, and well mixed. After a fortnight she may be put to work again, provided it be done with moderation, and only for half the day. She must not be allowed to overheat herself; but if this should happen, in spite of the precautions taken against it, she must be milked before the foal is allowed to go to her. When the foal is hungry, after a long absence from the mother, it must not be permitted to suck for a long time at once, but removed now and then from the teat.

A small quantity of very good hay is then given to the foal, and he is also allowed to drink of the mash provided for the mother. After eight or ten weeks the foal may be permitted to accompany its mother to the plough, and when she is employed in carting to small distances. Foals are weaned at the end of twelve weeks: some persons profess to have remarked, that those which are allowed to suck for a longer time, though they really grow larger and fatter, are nevertheless weaker when they grow up.

After the foal is weaned, the mare is no longer supplied with the substantial food that she had while suckling. If the udder appears to harden, or is painful to the mare, a hot stone should be placed in a vessel, and the milk made to run upon it, so that the vapour may come in contact with the udder. In this case, also, the udder should be washed and bathed in warm soap and water, and if it becomes very hard, it should be rubbed with burnt butter, or volatile camphorated ointment, procured from the druggist.

Foals are usually reared in a close pasture where there is abundant food for them, and this is certainly the best and most convenient method. Where, however, this convenience is not available, they may be reared in the stable.

When foals are to be brought up in the stable, they are tied up with a halter having a broad nose-band. They should, however, be let out twice a day, if it be only into the yard: but this must be done early, before they become too lively, or they will hurt themselves with all sorts of things. They should be tamed as soon as possible, by being accustomed to eat out of the hand. It is very useful to brush and curry foals from their first year. They should be early accustomed to allow their feet to be lifted up and struck; after the second year, the feet should be trimmed. At the same time a small quantity of oats should be given to them, and the supply of hay diminished; but they thrive very well when fed on green clover and tares.

The horse has twelve cutting teeth or nippers, six in each jaw, four canine teeth or tushes, and twenty-four molar teeth or grinders.

The nippers are subject to change, and afford the chief indication of the horse's age. The young animal is called a foal so long as he retains all his first teeth, that is to say, till the age of two years and a half.

In the third year the two front teeth fall out: those of the lower jaw are usually shed first: the space which they leave is filled up with an equal number of new teeth. These teeth are at first distinguished by a dirty yellow colour: in their upper parts they have a black cavity called *the mark:* the animal is then called a colt.

In the fourth year the two next teeth in both jaws are changed in a similar manner. The first teeth of the second growth are by this time partially filled up: they are also whiter, and the mark has assumed a pale brown colour.

In the fifth year the two outer teeth change in the same manner, and from that time the animal is a full grown horse.

The three pair of nippers lose their marks in the same order as they gained them. In the seventh year the mark in the centre teeth is effaced, in the eighth that in the next two, and in the ninth those of the outer teeth also disappear.

Such is the usual order: there are, however, exceptions, especially in certain races. Some horses, particularly the best, shed their teeth later: they also retain the mark longer. Such horses are always more robust, and attain a more advanced age: hence a horse which retains his marks long fetches a high price.

But horse-dealers try to imitate these marks in their old horses, by piercing or burning the upper part of the teeth, and sometimes do it so cleverly, that only the practised eye of a connoisseur can detect the imposition. But they can rarely imitate the order in which the marks fill up and lose their colour. The step of the foot in the foal and colt is broader than it is long; but there is often trickery in this—clever enough to deceive any one on casual inspection.

After the tenth year the first vertebra of the tail separates from the last of the spine, and the separation increases with the horse's age. The gums also contract as the animal grows older, so that the teeth appear longer: these organs also assume a whiteness more like that of lime than before. The cavities above the eyes deepen, the hairs surrounding them grow white, the hind quarters sink, and the lips no longer close. When these signs appear the horse is old, and his value, as far as regards the time that he may be expected to last, depends much more upon them than upon his actual age; for there are many horses which become unfit for use at the age of fourteen, while others continue useful till they are twenty or even twenty-one years old. I knew a horse which carried the post at the age of four-and-twenty.

Grain is generally the principal food of horses: most persons give the preference to oats. But when any other kind of grain is substituted for oats in quantity proportioned to its nutritive power, and mixed with straw of finer quality and greater quantity than usual, the most attentive observers are unable to discover the slightest difference. Rye is the grain most generally substituted for oats. The use of unground barley is disapproved by some persons, because, they say, a large portion of it passes through the body undigested; others, on the contrary, strongly recommend its use. Wheat is rarely used as food for horses: some persons who have been obliged to resort to it have found it very injurious; but various reasons induce me to believe that this evil entirely arose from not mixing the wheat with a proper quantity of cut straw; without this addition it is very apt to clog the stomach. At one time, when this kind of grain was very cheap as compared with others, I gave it to my horses with very good effect, but always mixed with a considerable quantity of cut straw.

The food of a horse is usually measured in oats, this being the most usual food. There is, however, no kind of food which varies so much in nutritive power as oats given by measure. Many persons have, therefore, very judiciously resorted to the expedient of giving their oats by weight, or at least of modifying the quantity according to this method. Of some kinds of oats the scheffel weighs but 36lbs., whilst of others it amounts to 54lbs. In such a case the light oats will not fully supply the place of the heavier, even if the quantity be regulated by weight: nine metzen of the former are not equivalent to six metzen of the latter, because a given weight of the former contains more husk and less farina. Ten metzen of the 36lbs. variety would probably be required to supply the place of six metzen of the 54lbs. Taking the 48lbs. oats, which may be considered very good, as the basis of the calculation, we may reckon three metzen or 9lbs. for a horse of average size employed in ordinary work: it is understood, however, that the same horse is to have 8lbs. of hay. With such food horses of this description usually keep up their strength very well; but when they are put to extraordinary work, it is proper to give them an additional quantity of food. Smaller horses, which are not put to forced labour, seldom have more than two metzen even of light oats. The large horses of Saxony, Westphalia, Bavaria, and Austria, are supplied with at least four metzen, and sometimes five. Waggon horses frequently have eight metzen, especially when but little hay and no cut straw is given to them. The difference of three and five metzen, the former for small, the latter for large horses, is often made without producing any great difference in the size and strength of the animal, or the manner in which they perform their ordinary work. Horses of the smaller races are, therefore, preferable, where they are not continually wanted to draw heavy loads; especially since, even in the latter case, the work may be performed by increasing the number of the horses employed.

Rye, which is most frequently used as a substitute for oats, produces the same effect when given in half the quantity of the latter by measure, or still better by weight. Some persons reckon the proportion of rye to oats for feeding horses only as 7 to 12: they admit, however that their horses thrive better on the former than on the latter.

The seed of pulse, such as peas, beans, and tares, the last of which is considered the best for horses, is not reckoned as of greater value than rye. They are, however, decidedly more substantial, as appears from the observations already made on their nutritive properties; and likewise from the testimony of those who are acquainted with this mode of feeding. In many countries these pulse constitute almost the sole nourishment of horses; they do not, as some persons assert, disorder the respiration of the animal. The English give them without reserve to their race-horses. The prejudice in favour of oats in preference to all other kinds of grain chiefly arises from this cause, that all diseases which may attack horses fed upon oats, in a country where this mode of feeding is not customary, are imputed to the oats, and the matter is talked of for years: whereas, if the same diseases had attacked horses habitually fed upon this kind of grain, some other cause would have been sought for and discovered. It is certain, however, that very substantial food should be cautiously given, or it will be likely to bring on indigestion. For example, mischief may easily arise when the servants, in the midst of the heavy harvest work, secretly put aside a certain number of sheaves of new rye, and give them to the horses without measuring the quantity: and yet many farmers who are perfectly aware of this trick shut their eyes to it, and regard it as a kind of established custom. Grain of the more substantial kinds likewise requires to be mixed with more or less of finely cut straw: with oats, this is not absolutely necessary, though always useful. To prevent the horses from blowing away the chaff, and separating the grain from it, the mixture should be wetted. This wet fodder, though it can never do any injury when cautiously given, will be likely to act as a cause of disorder if the horses are heated and eat it with avidity; an occurrence which will not unfrequently happen, especially when they have been taken to the field before they have finished their meal, and find the rest of it in the manger on their return. There are many reasons for never leaving moist food in the mangers.

Grain given to horses should have undergone fermentation; it should be dry, but not heated. In some seasons, badly gathered and heated oats occasion fatal epidemics among horses. Sprouted grain does not injure them, provided it has been housed in a perfectly dry state, and has not contracted a smell of fermentation. Malted grain, particularly barley, mixed with the food is considered very beneficial to horses, especially when given in the proportion of a third of the total quantity.

Some persons have effected great saving by having their corn crushed before giving it to the horses, for without this preparation a great part of it passes unchanged through their bodies. This may easily be done if we have a mill at our disposal; but there will then be still greater necessity for mixing the corn with cut straw.

The grain must always be sifted to remove the dust, unless it has been subjected to the more effectual process of fanning a short time before.

Most horses are fed upon hay in addition to their corn, and some have nothing else.

Where a choice can be had between the hay of poor, dry, arid meadows, and that of rich, fertile lands, a question arises as to which of the two is the more proper for horses. This is a point upon which opinions are divided. It appears, however, that when hay is mixed with a large quantity of corn, as an accessory kind of food, the hard, poor sort should be given; but where it is to constitute the principal part of the horse's food, the richer and more substantial kind is decidedly to be preferred.

It is certain that hay may be substituted for corn-feeding, but opinions are divided respecting the extent to which this substitution ought to be carried, and likewise with regard to its economical expediency; in fact, it is impossible to lay down any general rule on the subject. Eight pounds of hay are generally regarded as equivalent to a metzen of oats; and when estimated by weight, hay is said to bear to oats the ratio of eight to three. Very nutritious hay, grown on low meadows, or fodder made from clover, lucerne, or sainfoin, is undoubtedly more substantial, and may be estimated in the proportion of seven to three; whereas the same kinds of fodder, when coarse and poor, do not exceed the ratio of nine to three. But, generally speaking, it is found that when the quantity of hay is increased and that of corn diminished, the horses gain more flesh, and are better able to perform slow work, but do not stand long journeys or great exertion so well. If, on the contrary, the hay is diminished, and the corn increased in quantity, the horses grow lean, but become stronger and more lively; provided, however, that their supply of straw is increased. An increase in the quantity of one or the other kind of food will be found advantageous according to the particular circumstances in which we may be placed, and the prices of various kinds of fodder.

Some farmers think that the aftermath or second hay-crop is decidedly injurious to horses; but this is not the case when the hay is harvested dry and green, and grown on upland meadows, even though they are somewhat arid. The aftermath of rich meadows may perhaps be less fit for horses than for horned cattle. Many experienced farmers, however, do not like to have the aftermath consumed till February or March.

The longer the hay is left in cocks, the better is it adapted for horses: the best hay for them is that which is more than a year old. Hay for horses must be well made, and dried as quickly as possible, in order to preserve its green colour and peculiar smell; brown hay is not proper for these animals.

Besides the cut straw, other straw is likewise given to horses, particularly that which has been most broken in threshing: this is put into the rack. Contrary to general opinion, wheat straw is the best; it is the most proper substitute for hay when that kind of fodder is deficient, and is likewise the kind of straw which horses eat most willingly. The haulm of tares, lentils, and beans are, doubtless, still more nutritious, especially when part of their leaves are left on them in the green state. Some farmers are afraid to give pea-straw; they say that it sometimes brings on colic; but this opinion is founded on mere prejudice.

Opinions are divided respecting the propriety of feeding horses in the stable on clover and other kinds of green-meat. For my own part, I am persuaded that horses may be kept in this manner in good health and full vigour; at least, when a proper system is pursued. It is however, the quantity of this fodder, and the price current of grain, which determine the amount of saving that may be obtained by this mode of feeding. I kept my horses in this way for several years, when corn was high-priced, and always with advantage; they improved in condition without losing strength, even when they were not spared in respect of work. In the following winter, also, they were in surprisingly good condition. The transition from dry to green fodder must, however, be gradually made. At first, the clover must be cut up with straw; and first one portion of it, then two, given daily in place of oats; afterwards, when the clover is in flower, it is given to them in as great a quantity as they like; but then the corn is stopped. It is not good to give corn with green-meat, because the former then passes through the body undigested. If corn and green feeding are to be united, the corn must be given in the morning, and the horses not allowed any green fodder before noon, or any corn in the after part of the day. Green lucerne and tares (especially the latter) which have begun to form their pods are better for horses than clover. The same gradual change must be observed in passing from green to dry feeding.

Horses are sometimes turned out to grass in summer, either with the other cattle, or in fields by themselves.

If they are properly attended to, and left completely at rest, this removal to their natural state agrees with them perfectly well. But horses cannot often be left unemployed, and therefore it is rarely possible to have them turned out to grass. For a horse to thrive when fed in this manner, the pasturage must be abundant, but he will then spoil a great deal of it with his feet; hence two cow-pastures are reckoned for one horse-pasture.

We cannot here treat of the pasturage of horses on marshes or commons. These can rarely be used for working horses, especially when they are at a considerable distance. They are more useful for brood-mares and colts.

It is certain that plough-horses may be fed from autumn till the time when young green fodder can be procured, without the aid of corn, by means of roots and a large quantity of hay and straw; upon such food horses may be maintained in full vigour and perfect health. They will not, however, be fit for long journeys, such as are required in winter for the transport of produce.

The most suitable and profitable food for horses consists of carrots, washed and coarsely mashed, or cut. Twelve metzen of these vegetables are given with eight pounds of hay and a due proportion of straw, when the horses are to be put to laborious work. This plan of feeding is universally adopted in some counties of England, and found highly successful. In this country, also, it is well known that, when horses know the taste of carrots, they eat them with avidity, and thrive upon them.

As to potatoes, many farmers who have tried them have been very well satisfied with the result; others have not been able to accustom their horses to these vegetables, or have found that the animals lost strength when thus fed. I am not able to decide whether in the latter case the food was properly given. I have never tried this mode of feeding with my own horses, because it has never been consistent with my system of management. The potatoes should first be carefully washed, and then coarsely broken up. The horses may be accustomed to these vegetables by playing with them, making them eat out of the hand, then putting a few pieces on their food, and gradually increasing the quantity. If it be desired to substitute potatoes entirely for corn in feeding horses, each animal must have half a scheffel (50 lbs.) per day. But perhaps it is better to take away only half the corn and give four metzen of potatoes, in place of one and a half metzen of oats. The horse must likewise be supplied with hay and straw as usual. Some persons steam the potatoes. In a large factory in England eighty horses are kept on food thus prepared; when the same method has been tried in this country, the horses have absolutely refused to eat the potatoes.*

Turnips, of the kind admitting of transplantation, and rutabagas have also been tried as food for horses, and eaten by them as greedily as carrots. The animals must, however, be gradually accustomed to them in the same manner as to bread.

Some farmers feed their horses on nothing but the refuse of the threshing-floor mixed with hay and cut straw; when, however, the horses are required to work, they are allowed a feed of corn. In establishments where horses are but little used in winter, this plan of feeding may be sufficient. Brood-mares are often kept in this manner in studs, where they are not required to work.

All food should be given to horses in small portions. A horse should commonly be allowed three hours to eat; the attendants must, therefore, get up three hours before work begins to give them their first feed. The hours of feeding should be regularly observed.

Horses should be watered with great care in the stable and when quite cool. Water may indeed be given to them on the road, but they must be made to go on immediately afterwards. It is improper to give them drink immediately after they have eaten corn, they should have

* Probably because they were too watery and too much mashed: perhaps also because they had been allowed to turn sour. When boiled potatoes are to be given to horses, they must be prepared with great care, and day by day: they should also be boiled in steam, and not in water. I think, however, that boiled potatoes make the stomach of animals sluggish; I therefore give them only to those which are to be fattened. Horses fed on them grow sensibly fatter, but do not become spirited: they seem, indeed, rather to grow lazy.—French Trans.

some hay first. Some persons think that hard water is best for horses; but they prefer soft water, and drink more willingly from ponds than from clear springs. Hard spring-water should therefore be exposed to the air for some time before it is given to horses.

Cleanliness is of great importance to the health of horses; if it be neglected, a crust of sweat and dust collects on the skin, and gives rise to mange and other diseases. Agricultural horses cannot, indeed, be treated with all the minute attention bestowed on pleasure-horses; such as currying, brushing, dusting, and washing every time they return to the stable; but, at all events, they should be curried every morning, and have their hams, knees and feet washed every evening, when they have got dirty. A smooth shining coat, which lazy grooms can produce by washing the horses entrusted to their care, often conceals a great deal of dirt attached to the skin: but this is easily discovered by passing the finger forcibly the wrong way of the hair. As plough-horses cannot well be perfectly cleaned every morning, the operation should be performed at least once a week, on Sunday morning. Bathing is doubtless very beneficial to horses: not in the evening, when they return from work heated and tired, but in the morning.

The shoeing of the fore-feet is indispensable, excepting for horses which either work on sandy soils, or have peculiarly solid hoofs; a very valuable property, hereditary in certain breeds. The shoeing of the hind feet is often dispensed with where the roads are not very stony. In rural districts, where there is not much choice of farriers, shoeing is often very badly performed. The farmer should, therefore, take an opportunity of acquiring a good practical knowledge of the art of shoeing, that he may be able to direct and control the farrier. The shoe should fit the hoof exactly, after the latter has been properly pared. Particular care must be taken to guard against pricks, which result from the horse running a nail into his foot as he walks, or from a nail taking the wrong direction in shoeing: when this happens, the nail must be immediately extracted.

Colts must be accustomed at an early age to allow their feet to be lifted up and struck: they are not, however, shod till wanted for tolerably regular work. Broken or damaged shoes must never be left on the feet: they must be taken off as soon as the hoofs project beyond them; but may be replaced, if strong enough to be used again. For this purpose, horses should be sent to the forge about once a month.

Agricultural horses which are almost always out of doors do not require stables so spacious, lofty, and light as others which are at rest for the greater part of their time; nevertheless, the stable should be so constructed as to be moderately warm in winter, and cool in summer. Ventilation should be effected by means of windows; but above all things, arrangements must be made for completely carrying off the urine. The stalls should be so formed as to allow the horses to lie down, which, from the little sleep that they have, is very beneficial to them. Some horses never lie down; it is chiefly by constantly remaining in narrow stalls, that they acquire the habit of always standing upright. For instructions as to the mode of building stables for horses, I refer to the work of Gilly, already cited.

Young horses must be gradually accustomed to labour: the surest mode of effecting this object is to attach them to a plough on a light soil. At first, they should be entrusted only to very intelligent men, and constantly watched. Under these conditions, a colt may be used from the age of 2½ years, but only with moderation, and never for a whole day together: for this he will not be able to bear till he is four years old. He must be gradually accustomed to work for a longer time, and drag heavier loads. By this treatment he will gain strength, and not be injured, provided he be made to walk gently and regularly. A horse is rarely injured, even at hard work, when made to go slowly: it is by being forced to travel with excessive speed that he becomes heated and worn out.

Great regularity should be observed in the hours of labour. A plough-horse may, without exhaustion, be worked for six hours every day at ordinary work; if the time be divided into two equal portions, by a meal in the middle of the day: but they must not be taxed to the utmost, except in cases of necessity. In the winter season, when these periods are too short, the horses may be allowed to work for six or seven hours together: this may even be necessary when they are employed to draw loads to considerable distances.

As the feed of horses is increased when they are very hard worked, so also it may be diminished when they are unemployed, by taking away part of the ordinary allowance of corn: the diminution, however, should never exceed a third of the whole allowance.

A horse being an expensive animal, and very liable to injury, he should never be entrusted to any driver but one who is very steady and trustworthy. If it be necessary to employ drivers in whom we cannot place entire confidence, they should never be trusted out of sight: above all, they must not be sent upon journeys, excepting under careful superintendence.

The director of a rural establishment should frequently examine the harness of his horses, to see that it fits well, that all injuries are promptly repaired, and that it is greased and cleaned as often as required: servants seldom take any interest in these matters. I should recommend, particularly in establishments which often change their servants, that no mode of harnessing be adopted different from that which is commonly practised in the country, even though a more advantageous method should be known.

There is some advantage in yoking four horses two by two, rather than in single file; but the former method requires the employment of men who perfectly understand driving and riding, and will take a liking to the horse which they mount, and spare him as much labour as possible; otherwise, the horse so used will certainly be exhausted and quickly worn out. There is some difficulty in changing the carrier in a team.

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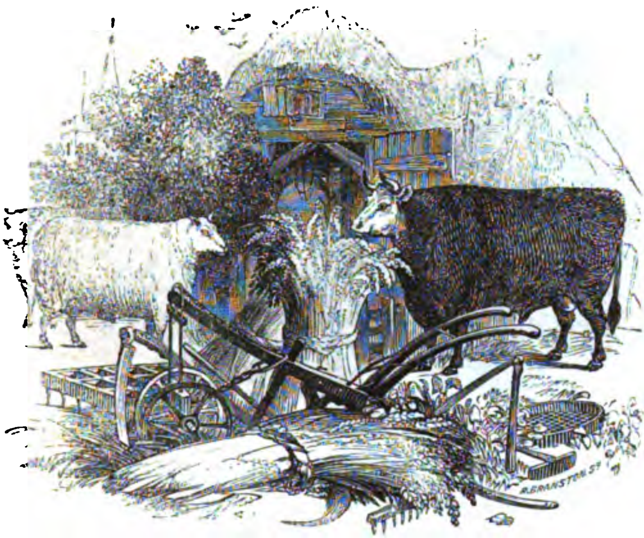

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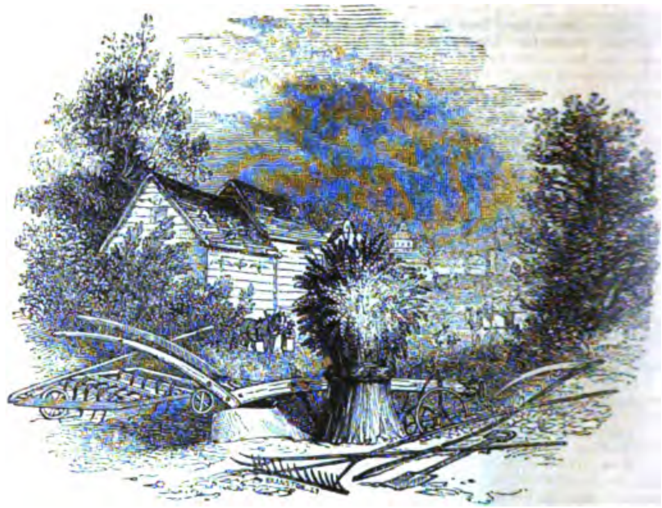

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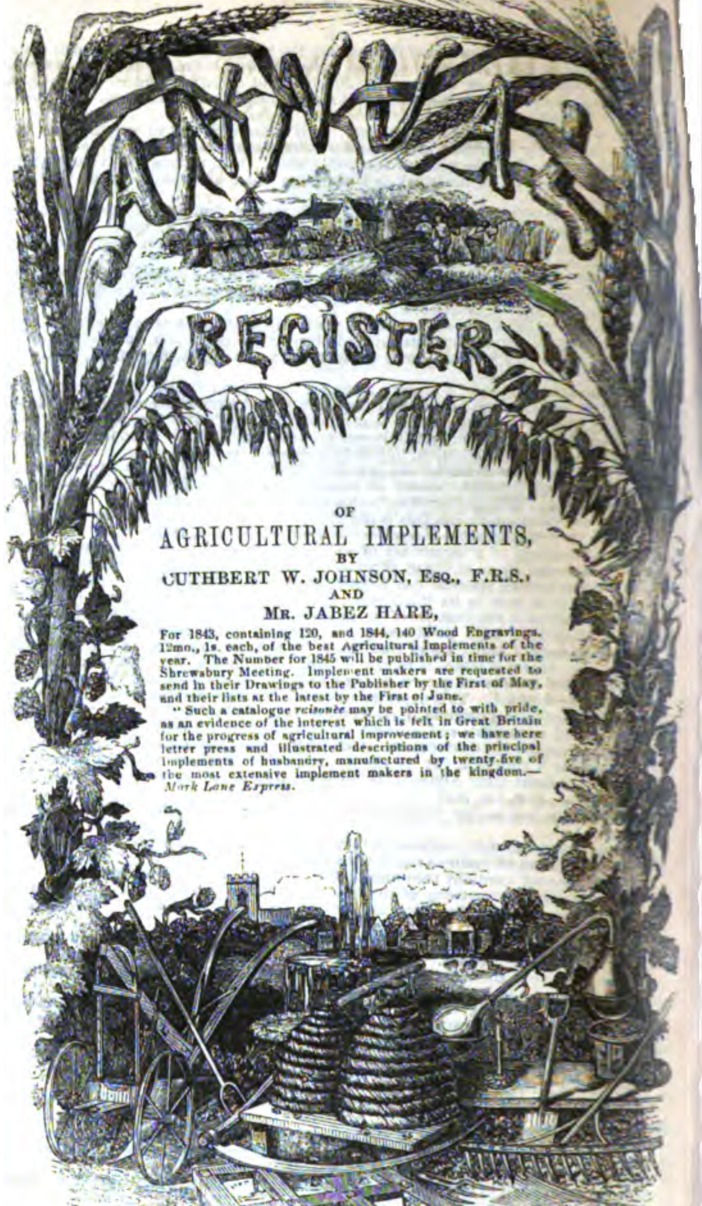

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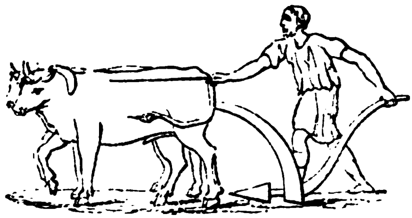

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Sun	7,157,875	Guardian	456,094
Phœnix	4,746,288	Alliance	590,674
Royal Exchange	4,554,949	Union	294,585
ROYAL, FARMERS, to Mar. 25, 1844.	3,655,987	Imperial	707,866
Globe	1,056,159	London	282,877
Atlas	818,737	Protestant Dissenters	165,590

COUNTRY INSURANCE OFFICES.

Norwich Union	9,618,806	Essex and Suffolk	1,135,798
ROYAL, FARMERS	3,655,987	Kent	297,805
Yorkshire	2,830,732	West of England	911,720
Suffolk Amicable	2,099,454		

TOTAL AMOUNT OF PROPERTY INSURED IN THE ROYAL, FARMERS' OFFICE TO THE 25th OF MARCH, 1844.

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Life Department.

The advantages of Life Insurance are as yet but little understood, and in but very few instances embraced by the agricultural population of this kingdom; yet it must be manifest that in a country where such a great proportion of the soil is subject to the laws of entail, copyhold tenure, and leases of different descriptions, the value of which mainly depends upon the duration of human life, that the landed interest possesses, through the members of its own class, ample means of maintaining an Institution for Life Insurance, the effects of which must be to encourage industry and economy, to lighten the pressure of payments which depend upon the lives of individuals, and to alleviate the melancholy consequences in which the widow and the orphan frequently become involved by the decease of the head of the family.

The owner of the soil, from the charges he is frequently compelled to make upon his estate, is deeply interested in Life Insurance, without reference to his connection with the tenant; but here also he is interested, inasmuch as if the tenant has secured himself by a Life Insurance, the landlord may be spared the painful feelings of paying himself arrears of rent, too frequently due at the decease of the tenant, out of the stock of the farm, and to which alone the widow and family can look for the means of future existence, or perhaps temporary support. To the tenant Life Insurance is of paramount importance, inasmuch as by laying aside a small amount annually he may secure a sum at his death for the benefit of his family, which may afford them a provision commensurate with the sphere in which they have been accustomed to move.

Nor in these advantages is the labouring class forgotten, as a plan has been arranged whereby that portion of the population will be enabled, in proportion to their means, to invest their small savings in such a manner as may secure, if not a full support, at least a moderate maintenance in sickness and old age. Although the savings of the labourer must of necessity be limited, yet it is well known to those who have paid attention to the subject, that the sums now annually contributed to benefit societies by that class, including very many expenses attendant upon them, might be applied in a manner which would in the end be much more beneficial.

Thus as the interests of the landlord, tenant, and labourers, are interwoven in their respective positions in life, so are they linked together closely in the beneficial effects which must result from availing themselves of the advantages of Life Insurance. To the two former classes, therefore, on their own account, as well as to set an example to, and to promote the comfort of the latter, this Institution, from the intrinsic merits of the principles of Life Insurance, and from its peculiar constitution, looks with confidence for that support which will render it worthy of that powerful class, the landed interest of Great Britain.

Nor is it only to the agricultural class that this Institution offers its advantages; it holds out a resource against the loss of income in all its shapes and bearings: it provides a fund for old age, for the clerk whose income fails with his office; for the creditor whose whole security is the life of his debtor; for the husband whose only income is his wife's dower; for the dependant upon an annuity for another's life; for the tenant bound to repairs, or to pay fines for renewals; for those parents or guardians who have paid apprentice fees, and such apprentice dies, and it then becomes an object to regain the money so expended; for those who would provide a fund for the education or marriage of their children, or who would secure an independence to the younger branches of their family; and in general for the many contingencies, against which a moderate or uncertain income affords no adequate provision.

Parties by whom Life Insurance may be advantageously adopted.

1. By Husbands and Fathers, to make provision after their death for their Widows and Children.
2. By the Young, to make provision for themselves in their declining years.
3. By Parents, to provide endowments for Children.
4. By the Possessors of Entailed Estates, to provide for the younger branches of their families.
5. In Marriage Contracts, to secure the terms of settlement.
6. By Creditors, to compensate the loss which the death of their Debtors might occasion.
7. By the Borrower, to secure, in case of death, a fund to repay the loan.
8. By the Holder of a Lease, dependent on a Life or Lives, to provide a fund to meet the fine, increase of rent, or loss of capital whichmay ensue.
9. By Expectants of Property in Reversion, to ensure a portion of it against contingency.
10. By Purchasers of Annuities on the Lives of others to secure the capital laid out.
11. By all who have a pecuniary interest in the existence of a Life, to guard that interest from total ruin through failure of the life.

Important Facilities for Insuring.

Premiums upon Life Insurance may be paid yearly, half-yearly, quarterly, or monthly, in one payment, or in a fixed number of payments.

Policies will be granted, the amount insured to be received at the end of a term of years, although during the life of the insured.

Short Terms may also be assured, at greatly reduced premiums, to meet reversionary interests or contingent remainders.

In order to suit the convenience of those who anticipate an increase of income, arising either from promotion in office, increase of business, accession of property, or any other cause, a scale of premiums has been arranged to take a lower rate at first, gradually ascending until it becomes fixed for the remainder of life.

So, on the contrary, where persons prefer paying a higher rate early in life, and so go on decreasing until the premiums become very small, a scale of premiums has been provided to meet these views:

When the Insurance is for the Whole Life, ONE-HALF OF THE PREMIUMS only may be paid for the first five years after the date of the policy; the other half to remain subject to the payment of interest annually, to be deducted from the amount assured, or to be previously paid off at convenience.

By a late Act of Parliament, 5th and 6th William IV., cap. 64, Policies for any sum, not exceeding £50., may now be issued at a stamp duty of 2s. 6d., and from that sum to £100 at a duty of 5s., instead of the former duty of 20s., which will be found of great advantage to those who wish to insure only small sums at one time.

Life Policies will, at any time after four years, be purchased at their equitable value; or should circumstances render it inconvenient to continue payment of the premiums, another Insurance for a less sum, without any further premium, may be obtained.

The Advantages of Life Insurance.

A popular writer has, on this head, the following observations:—"It may be felt by many, that, admitting the duty in full, their income is nevertheless insufficient to enable them to spare even the small sum necessary as an annual premium for Life Insurance. The necessities of the present are, in their case, so great that they do not see how they can afford it. We believe there is no obstacle which is apt to appear more real than this, where an income is at all limited; and yet it is easy to show that no obstacle could be more ideal. It will readily be acknowledged by everybody who has an income at all, that there must be some who have smaller incomes. Say, for instance, that any man has £400 per annum; he cannot doubt that there are some who have only £350. Now, if these persons live on £350, why may he not do so too, sparing the odd £50 as a deposit for Life Assurance? In like manner, he who has £200 may live as men do who have only £175, and devote the remaining £25 to have a sum assured upon his life; and he who has £100 a-year may live as those who have £85, applying the other £15 for a Life Assurance. The latter sum would secure nearly £750 to the family or survivors of a man twenty-seven years of age when he effected the assurance, and nearly £600 to the survivors of a man thirty-six years of age. £15 would secure to a person 23 years of age, an annuity of £50 on attaining 50, to a person aged 31 on attaining 55, to a person 38 years of age on attaining 60, and to a person aged 46 on attaining 65. It would secure an annuity of £60 to the widow of a man aged 30 on his demise, his wife being the same age; nearly £500 for a child just born on attaining 21, and nearly £300 to a child 6 years of age on attaining 21. It may require an effort to accomplish this; but is not the object worthy of an effort? And can any man be held as honest, or any way good, who will not make such an effort, rather than be always liable to the risk of leaving in beggary the beings whom he most cherishes on earth, and for whose support he alone is responsible?"

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(With power to add to their number.)

[The gentlemen whose names are marked thus † are Directors of the Association.]

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WILLIAM YOUATT, Esq., CHIEF CONSULTING VETERINARY SURGEON.

Messrs. OLIVER and LINDSELL, Raymond Buildings, Gray's Inn, SOLICITORS.

Bankers: The London and Westminster Bank, Throgmorton-street.

1. The especial object of this Association is to give to Farmers, Graziers, and Owners of Cattle, the best means of protecting themselves against losses

by those *diseases and accidents* which they can neither foresee nor control, but which have hitherto been most injurious, and often ruinous to thousands.

2. In effecting this, two great principles must be kept in view, viz., *Economy* and the *Prevention of Fraud.* To secure *economy* the Association is *mutual.* Nobody can be benefited by charging too high, save the subscribers themselves; none injured by paying too little but the subscribers themselves, should they become claimants.

3. To *prevent fraud,* no owner will receive in any case more than two-thirds of the bonâ fide value of the animal lost, but he will be entitled to one-third of the value of the skin and carcass.

4. Subject to these leading principles, and some other regulations, the whole of which cannot be set out in this prospectus, the Association will ensure the NEAT CATTLE and COWS (excepting Cows kept in towns) of all they consent to admit as Associates, against death, whether occasioned by sickness, *unforeseen accidents,* calving, contagion, *pleuro-pneumonia,* or by the slaughter of the animals in consequence of being tainted with any disease.

5. The Association, however, will not pay for animals which may die of blows, wounds, fractures, bad treatment directly caused by the owner, or be his instigation, or direction, or neglect, or owing to any disease with which they might be affected before they were assured. They must be in a healthy state when offered, and not neglected afterwards; otherwise the contract will be void.

6. An owner may insure his stock, and sell, exchange, substitute, or increase, up to the value he insures; but he must never increase the value of his stock beyond the value for which he has paid, without effecting a further insurance, and paying in proportion, otherwise he will forfeit his contract. In cases of "substitution," the insured must make a *monthly* return of new animals admitted; but in "additions" a new insurance must be effected immediately.

Graziers in the habit of constantly changing their Stock, when insured, will be permitted to do so, upon payment of a small additional per centage.

7. Insurances may be effected in two ways:

1st. The Owner may have his stock valued by the Inspector of the Association, and pay upon the full amount, and receive two-thirds of the market value of the animal dying (*i.e.*, the value of it the day before the disease manifested itself), and allowed, in addition, one-third of the value of the skin and carcass. For example:

If the full value of the stock, allowing for the improving condition of the animals during the coming year of insurance (for their increasing value during that period *must be* calculated), amounts, or will amount, to £1,000, then the premium on £1,000 being paid, if any one or more die, two-thirds of their market value will be paid, be they worth what they may.

2nd. If the owner elects making his own estimate and average, he will receive two-thirds of the said value of the animal dying, *provided* such value be not more than the average he has specified; and when of smaller value, two-thirds of such smaller value only, the Directors having power to grant additional compensation, should they see fit. For instance:

If the stock consists of 100 head, and the average fixed be £10, then the premium to be paid will be upon £1,000; and if one or more die, of the value of £10 (to be certified by the Inspector), the Owner will be paid two-thirds of his average (and, in addition, allowed one-third of the value of the skin, &c.); if worth only £8, then two-thirds of £8, &c.; but if th eanimal were worth £20, he will receive only two-thirds of his average (£10).

8. No Animal under the age of 12 months will be insured.

9. The Association will not interfere with the treatment of the usual Veterinarian or Farrier of the Owner. Should they, however, deem it requisite to do so, they will pay the expense out of their own funds. But in all cases of serious sickness, the Association will require immediate notice to be given to the Agent and Inspector.

10. If the Veterinarian recommend that the sick animal ought to be kept separate from the rest, it must be so separated, or the contract with the Association will be void as regards any loss arising from contagion.

11. In extreme and urgent cases the Owner will be allowed the power to slaughter sick animals, *provided* it appear that he would have sustained injury by not doing so before the Inspector could arrive; the propriety of so acting to be certified by the Inspector.

12. All animals will be protected, and the Owner be entitled to claim payment for the loss *of every animal dying* 21 *days after the day on which the proposal is made, and a receipt given by the Agent for the Premium.*

13. A reserve fund of 5 per cent. per annum, to form a guarantee fund for the Association to the extent of £50,000, to meet extraordinary *losses*, will be made.

14. Should the rates charged be more than sufficient to meet the losses, expenses, and contribution to the guarantee fund, the Association may place to the credit of every one assuring, his proportion of the surplus in reduction of his premium of insurances for next year.

15. A consulting Veterinary Surgeon, being a Graduate of the Colleges of London or Edinburgh, or more than one, if required, will be appointed to each Agent's district.

16. The insurance will only extend to Cattle upon the farm or lands specified in the Declaration.

17. In the event of any person being insured in any other Society, notice must be given, in order that an indorsement may be made upon the Declaration to that effect.

18. Losses from lightning or fire will not be made good, such being paid for by the Fire Offices.

This Association has been formed on the *Mutual* principle, as being the most economical, and the best and most legitimate mode of individual protection. Experience has demonstrated the security of well-established and prudently-managed Mutual Insurance Societies. In such a society there are no conflicting interests between the Insurers and the Insured; the *profits* are not consumed in the payment of interest upon a subscribed capital, but the contributions of the Members *belong exclusively to themselves*, and whatever surplus remains beyond the amount of losses and expense of management is returned either in the shape of a *bonus*, or is applied in reduction of future Premiums.

Had the "Farmers' and Graziers' Cattle Insurance Association" been formed as a proprietary Company, with a large subscribed capital, it might possibly have paid a handsome per-centage to the Shareholders, but the Rates must have been higher, and the general advantages to the Insured would have been diminished.

The leading feature of the proprietary system is, that the subscribed capital affords a guarantee or security for the payment of claims which the mutual system lacks, and that the Assured is thus compensated in safety for what he wants in money. But the hollowness of this reasoning is evident, when it is considered that a combination of Assurers, each paying fully what experience declares is necessary to make good their mutual arrangements, is a transaction free from all risk—in the ordinary sense of the word—and can only fail in the event of a change in the laws of nature, or such an alteration in the condition of the country as no kind of security could withstand.

In the case of this Association, the risks have been carefully calculated from the best experience which could be obtained as to the rate of mortality amongst cattle, and the results hitherto confirm the conviction that the Premiums are sufficient to meet all ordinary contingencies, as well as gradually to form a guarantee-fund; and the success which it has already had, and which, it is presumed, has placed it on a sure and permanent basis, renders a paid-up capital altogether unnecessary.

Thus, then, the Assured has not only the benefit of protecting himself against destructive losses among his cattle, at the lowest rate of Premium consistent with the risk, but retains in his pocket what would otherwise have gone to the payment of interest on capital, had this been a proprietary Company.

There are, at the present time, many Societies for the Insurance of human life on the Mutual principle, and although they depend entirely and exclusively on the contributions of their members, there is no instance on record where a claim has fallen in which those contributions could not meet.

The system of Mutual Assurance, conducted on a large scale and upon a proper footing, involves no risk; while, at the same time, seeing that any surplus beyond the amount of losses and expense of management is secured by the Insured in future diminished premiums, the charges must be considered as reduced to the lowest rate which the necessities of the case require, and are at the same time sufficient to meet every contingency.

N.B. References can be given to several persons in Dorsetshire, Cheshire, Lancashire, Nottinghamshire, Yorkshire, &c., who have experienced losses, and have been promptly paid. In these cases some have lost six and some nine animals.

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The rates of Premium to be charged for Agricultural horses are under consideration.

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HENRY FLOWER, Secretary.

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The work should be in the hands of every farmer in the kingdom; but if this be not accomplishable, four or five neighbouring farmers might have it, as common or joint-stock property among themselves; and making the subject in the several numbers matters of discussion, could not fail to render them more conversant in the various improvements now spreading in agriculture. Let the numbers be lodged, when well conned over by the members of the little fraternity, at one of their domiciles. We conclude by saying that the Farmers' Magazine is a library in itself, for the end desired; and, whether from the extracts of the most approved authorities, or from original matter, it is among the best publications of its kind in our day.—*Chester Courant.*

The present number abounds with matter of a practical and highly interesting nature, and fully sustains that reputation for which it has long been conspicuous.—*Bolton Chronicle.*

This is indeed a periodical of genuine merit, and one which cannot well be dispensed with by those cultivators of the soil, whose enterprising spirits urge them to keep pace with modern improvements in agricultural science. The breeder of stock, however experienced, will also enrich his fund of information by a perusal of the interesting and useful pages of this intelligent publication, which in fact furnishes a concentration of all the experiments and useful discoveries in the science of which it so ably treats.—*Cumberland Packet.*

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This ably edited Magazine contains in every number a vast fund of information, exceedingly interesting and useful to the agriculturist. It is besides the cheapest periodical of its class. We heartily recommend this publication to our agricultural friends.—*Kent Herald.*

Is embellished with two engravings beautifully finished. The contents of the number are varied, but are, for the most part, devoted to agricultural matters, pointing out the improvements in the cultivation of the soil, manuring, feeding, and fattening cattle, &c., &c. This is one of the best and cheapest works of the kind that is published. It is, in fact, within the reach of all agriculturists.—*Western Times.*

This is a work which we can safely recommend both to the theoretic and practical agriculturist. It is replete with valuable information. The part for this month is embellished with two engravings.—*Blackburn Standard.*

The number for the present month contains two beautiful engravings. But these, altogether valuable in themselves, are nothing as compared with the work itself, which abounds with information highly interesting to all, and of great benefit to those engaged in agricultural pursuits.—*Bolton Chronicle.*

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